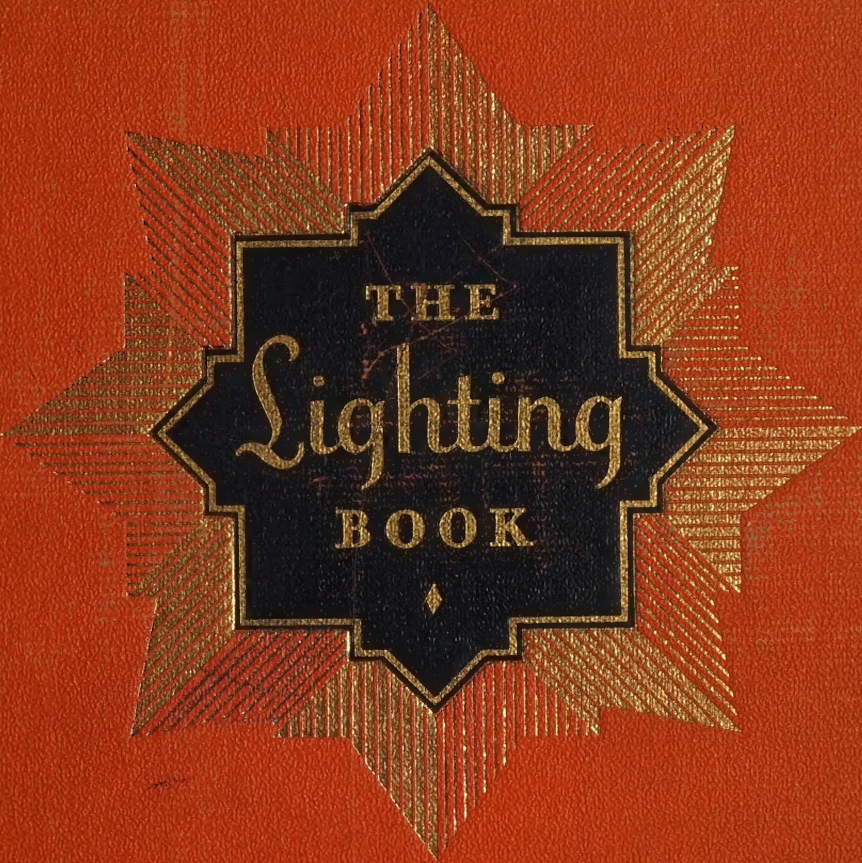
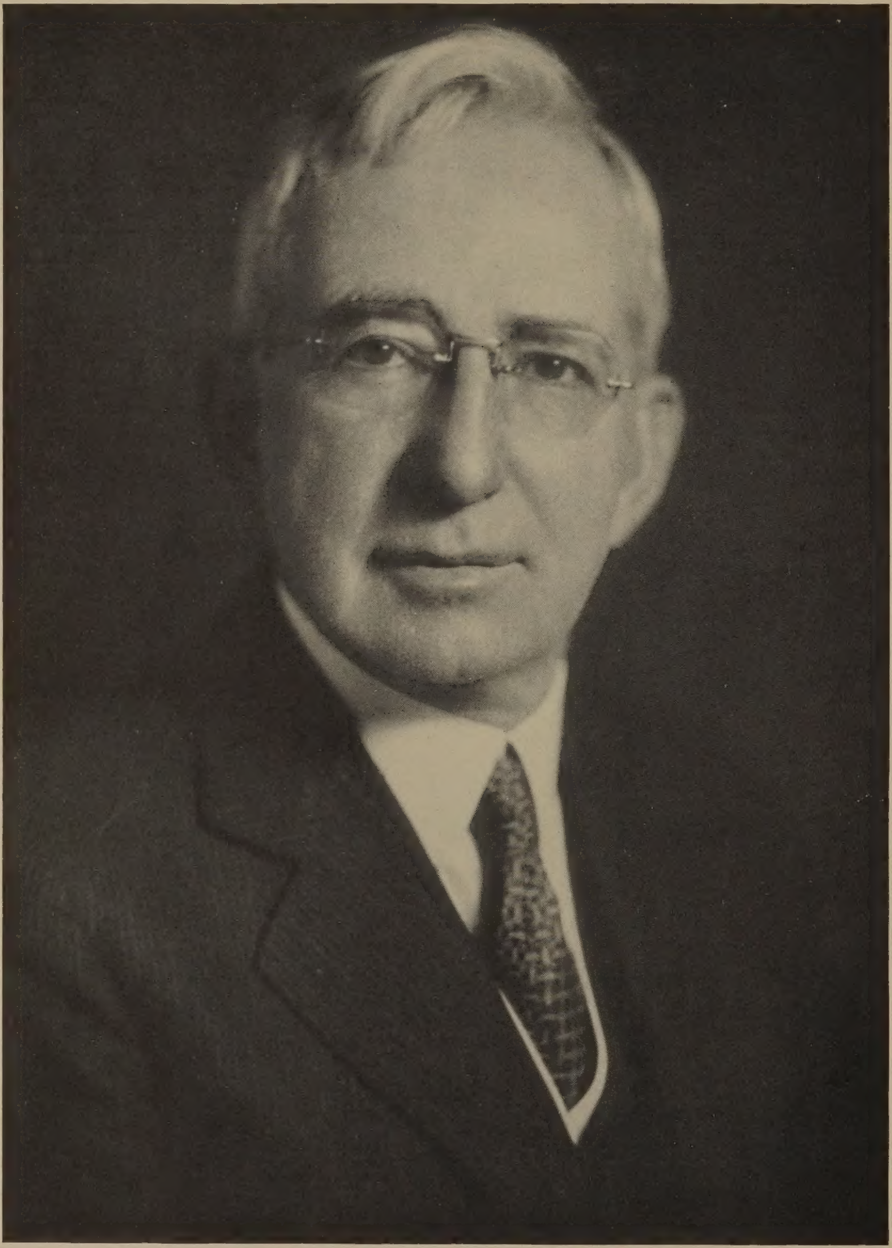
UNIVERSITY OF ARIZONA
39001007328910



THE Lighting BOOK

THE LIGHTING BOOK



AUGUSTUS D. CURTIS

Founder and President of Curtis Lighting, Inc., Pioneer of Indirect Illumination

The LIGHTING *Book*

A book of reference for the planning of practical and artistic illumination for all types of interiors and of exteriors

by J. L. Stair

Chief Engineer

CURTIS LIGHTING, INC.
CHICAGO
NEW YORK-ANTWERP

Copyrighted 1930
CURTIS LIGHTING, INC.
Chicago.

UNIVERSITY OF ARIZONA
621.321
C97
LIBRARY

DEDICATED
TO
ALL WHO HAVE CONTRIBUTED
TO THE
ADVANCEMENT OF THE LIGHTING ART
BY RESEARCH AND INVENTION
AND BY THE
APPLICATION OF ITS CORRECT
PRINCIPLES

* * *

PUBLISHED IN THE YEAR
OF LIGHT'S GOLDEN JUBILEE
1929

74248

CONTENTS

PART ONE

HISTORY OF THE LIGHTING ART . . . . . . *Pages* 15 *to* 22

Man's attempt to produce artificial illumination

PART TWO

THE STORY OF CURTIS LIGHTING . . . . . *Pages* 25 *to* 32

Its contribution to the improvement of lighting conditions

PART THREE

ENGINEERED LIGHTING . . . . *Pages* 35 *to* 58

Harnessing and Controlling Light

Utilitarian requirements . . . . *page* 36

Hygienic aspect of Good Lighting . . . . *page* 42

Artistic considerations . . . . *page* 49

PART FOUR

MODERN LIGHTING PRACTICE . . . . . . *Pages* 61 *to* 272

General Principles

Applications

Offices, Conference Rooms . . . . *page* 69

Banks . . . . *page* 79

Stores, Shops and Display Rooms . . . . *page* 91

Churches . . . . *page* 107

Theatre and Stage . . . . *page* 121

CONTENTS

Auditoriums, Public Assembly Places . . . . *page* 131
Government and Municipal Buildings . . . . *page* 137
Educational Buildings, Schools, Colleges, Libraries . . . . . . *page* 143
Museums of Art and Natural History . . . . *page* 157
Clubs . . . . *page* 165
Lodges . . . . *page* 169
Hotels . . . . *page* 175
Cafes, Restaurants and Dining Rooms . . . . *page* 181
Public Spaces, Lobbies, Corridors, Railway Stations . . . . . . *page* 187
Hospitals . . . . *page* 193
Residences . . . . *page* 201
Industrial Plants, Factories . . . . *page* 207
Drafting Rooms . . . . *page* 215
Sports, Indoor and Outdoor . . . . *page* 219
Floodlighting . . . . *page* 233
Show Window Lighting . . . . *page* 245
Display Case Lighting . . . . *page* 259
Miscellaneous Applications . . . . *page* 265

PART FIVE

PLANNING LIGHTING SYSTEMS . . . . . . *Pages* 275 *to* 312
Equipment for producing lighting effects . . . . *page* 277
Lighting Data, Tables and Definitions . . . . *page* 309
INDEX . . . . *Page* 313

PREFATORY NOTE

WE LIVE in a world of light. Light is one of man's greatest benefactions. Truly the light is sweet, says the good book, and a pleasant thing it is for the eye to behold the sun. Light enables us to perceive the objects about us. It is a revealer of nature's divers beauties. The radiance from our solar planet gives energy to living things. In a thousand subtle ways light, whether natural or artificial, influences our happiness, our health, and our success.

We have so much of light, both good and bad. We accept its benefits, we become accustomed to its dangers when wrongly used. Most bad practices are traditional, others creep in. We complain and then forget. We should insist that some change be effected, because light can be made our servant, our minister, and our co-worker.

The public attitude toward proper lighting is changing. Greater interest and discrimination is being shown and better illumination demanded as public taste improves. Light is becoming a vital factor in our domestic, spiritual and commercial life.

To assist in cultivating an appreciation for rational lighting this book has been written. It is not intended to be a complete treatise, but to suggest a few of the accomplishments in the application of modern light sources and some of the possibilities. We know that there is more to the practice of illumination than its mere technical demands. An attempt has, therefore, been made to point out some of its refinements.

Just ten years have passed since our volume known as "Lighting From Concealed Sources" was issued. Much progress has since been made, yet experience has borne out the fact that the fundamental principle promulgated in that publication was basically correct; namely, that lighting should be from sources concealed.

How better should this book begin than by a short review of the fascinating historical background of an art and science that has revolutionized our daily existence? Important usages in the various ages of man are suggested, especially those that have influenced our present day practice.

Freedom from technical discussion and procedure will be noted as one of the features in the treatment of the subject. Brevity has been essential. Each section could readily be expanded into a volume. So much compression requires the wholesale sacrifice of detail. The grouping of the material is planned to simplify reference.

The deliberate use of profuse illustration clearly exhibits the various lighting applications. Examples have been selected that reveal some interesting points in architecture and decorative design or help to obtain an understanding of the subject. Each illustration tells a story all its own, a particular application of the lighting principle, or a variation of a method.

The mechanics of the subject is treated briefly in the closing pages of the book, with technical information, charts, diagrams and equipment for producing lighting effects. It is indispensable that we know some of the fundamental principles so as to, at least, be able to solve the ordinary lighting problem.

Hundreds of instances may arise in the mind of the reader for which no illustration or solution is offered. These as well as more complicated questions should be referred to specialists in lighting. In this the age of specialists every service is in the hands of experts, and the function of the specialist in illumination is to inform and guide us in the use of light.

October 21, 1929 J. L. S.
Chicago

PART ONE

HISTORY OF THE LIGHTING ART

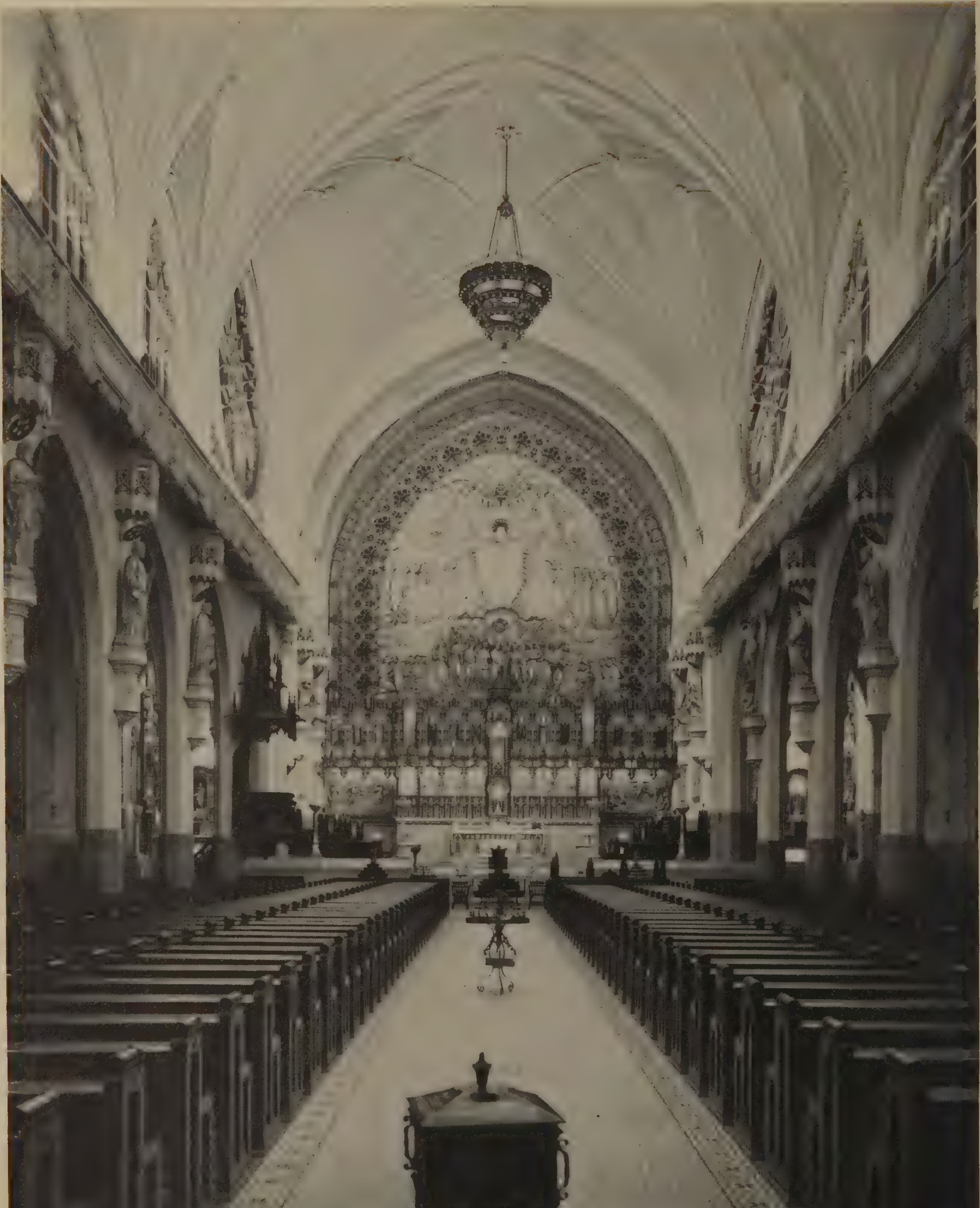
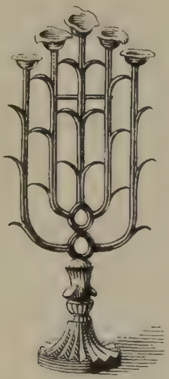


FIGURE 1—The Church of the Sacred Heart, Montreal, Canada. By lighting carefully planned to produce an atmosphere of reverence, the architectural detail and the significance of the religious symbolism are given emphasis.



WE POSSESS no written record of when light and fire first became useful to man. Mythology tells us that the benefactor, Prometheus, gifted with great wisdom, ascended to heaven, lighted a torch at the chariot of the sun and brought down fire to earth.

Whether or not the "flight through the heavenly portals" is authentic, the tradition is an interesting one and supplies us with a beginning for the story of the development that has been taking place steadily through thousands and thousands of years—the development of man's attempt to produce, maintain and improve artificial light.

When the world was new, in ages vastly remote, man lived in a totally different fashion than is common for the human of today. In the beginning of his existence upon the earth man had his habitation in the dense forests, surrounded by wild life, by ferocious and crawling things. His dwelling was a cavern, dark, dank and forbidding, into which an occasional reptile or winged mammal intruded. He emerged at the break of day and at night, in the recesses of the sheltering rock, sought protection from the unpleasant elements and the savage beasts of the forest.

Exposed to the dangers incidental to this sort of existence, early man was compelled to devise means for his warmth and protection. Weapons of stone found in excavations include arrowheads, stone axes, spearheads, and implements with finely serrated edges. In these early ages our ancestors were hunters primarily.

Necessity in all times has prompted the invention of utensils as well as weapons. Fire and light, borrowed from the heavens, man soon discovered how to appropriate to his needs, for the warming of the body, for the roasting of meats, and for protection from wild beasts. Fire and light seemed to possess an uncanny power over the lurking wild life of the jungle. Beasts kept their distance from the unfamiliar and mysterious phenomenon. The campfire was more effective than a sentry, and a burning fagot at the entrance of the cave gave more protection than an armed guard.

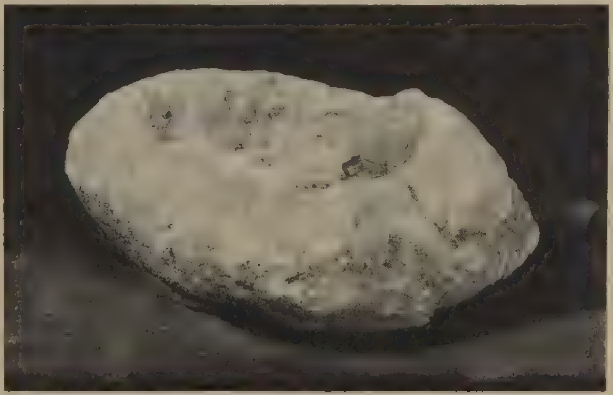


FIGURE 2—Famous prehistoric lamp of the Mousterien Age. Approximate date, 80,000 years B. C. From the Curtis collection of ancient lamps.

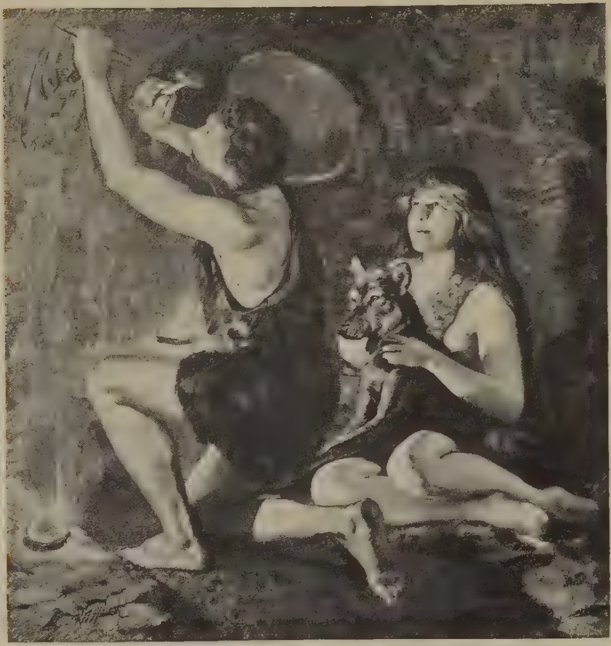


FIGURE 3—Cave dwellers used saucer shaped stone lamps burning animal fat for illumination. This is the earliest type of lighting fixture.

When, after the discovery of fire and light, the relations of the caveman and his wild animal neighbors became more tranquil, he fell to improving the means of using his new possessions. The burning brand or pine knot, unsatisfactory in many ways, was replaced promptly when man found that the fat of animals would sustain combustion. Pools of dripping grease, collected in depressions of the ground, probably gave our savage ancestors the idea of hollowing out stones, which served them as lamps of a sort.

Above the little River Orneau in northeastern France, on the face of a limestone cliff, we catch a glimpse of the earliest human life in Europe. It was here that rough tools of flint and bone were discovered, among the ashes of an earthen hearth, about fifty years ago. At night these prehistoric men had a light, other than the wavering firelight, to keep out the terrors of the dark. In shallow stone bowls they burned the fat of the beasts they slew, and the flame of these crude lamps lit up the pictures of those same beasts painted on the walls. The herdsmen were artists, the first artists in the history of the world. On the walls of caves in France and Spain the paintings of this time can still be seen in amazing vividness.

Stone lamps of this prehistoric period have been discovered. One of the most ancient of these is illustrated in Fig. 2. This lamp is now in the private Curtis collection of ancient lighting devices. Two other lamps of similar character are known to man. One is in the possession of the National Prehistoric Museum at Les Eyzies, France. The second is in the Museum of San Germain.

The lamp pictured in Fig. 2 was found at Le Moustier, France, which is located in the Department of Dordogne, close to where the famous Moustérien skeleton was discovered in 1908. This lamp was unearthed by the archeologist, Count Byron de Prorok, on August 26, 1928, at a slightly lower level than the other two mentioned above, and probably is the oldest so far discovered. Since it was reposing at a depth of thirty feet below the Neolithic and Magdalenian levels, the archeologist assigns to it an age of at least eighty thousand years. Along with the lamp were found flints, bones and ashes. These represent the remains of prehistoric implements and animals similar to our bear and reindeer.

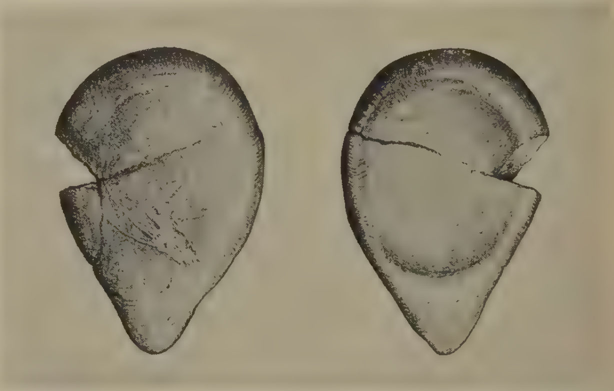


FIGURE 4—Old stone lamps found in Southern France, doubtless used by primitive men to light their caverns.

The torch is considered the most primitive lighting device, which, in the simplest form, was a burning brand taken from the campfire, and in its more elaborate phases developed into the artistic cressets and flambeaux of the Middle Ages. Torches took on many forms in various countries of the world. In some cases we find rod-like ma-

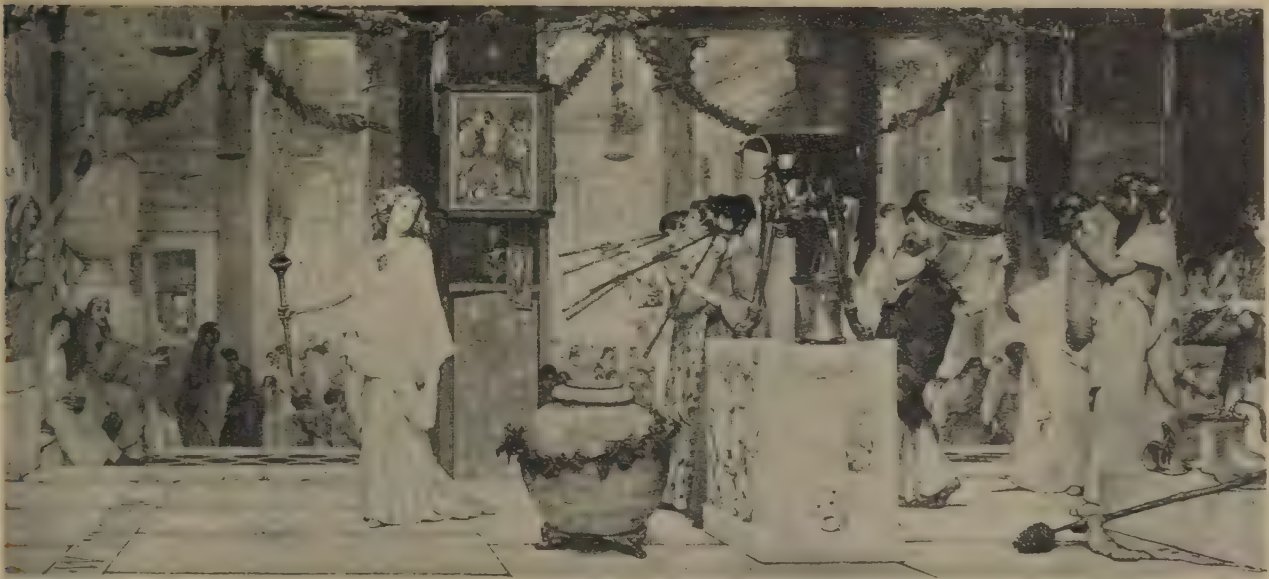


FIGURE 5—The Vintage Festival. A painting by Sir Lawrence Alma-Tadema. Here are illustrated the lighting methods of the old Roman world. The figure leading the procession carries the torch which was the most common form of illuminant. The pedestal in the foreground supports the brazier while the background discloses a type of suspended luminaire.

terials, such as cane, fastened in bundles and the ends wrapped in flannel or wool material. Such devices were used in classical times.

Although the torch is usually thought of as an object to be held in the hand, requiring the attention of one man, it was found that, especially for use in the home and the illumination of ceremonies and primitive rites, there was some need for making the torch stationary. This probably marked the first phase in the development of a fixture for use in artificial lighting.

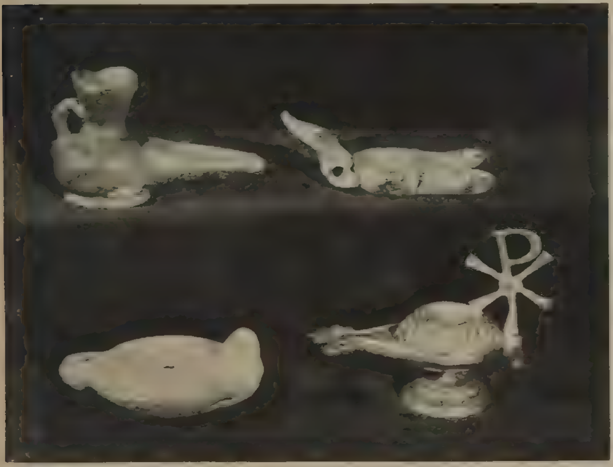


FIGURE 6—Examples of very old vegetable oil lamps. From the Curtis collection of ancient lamps.

After a time there was need for improvement in lighting devices. Ancient peoples, becoming ingenious in the use of illuminants, found that vegetable oils as well as animal fats could be employed for purposes of lighting.

The essence of simplicity in the making of a lamp was a saucer type vessel of pottery, with the rim pinched in to hold a short wick of vegetable fiber. Crude saucer lamps were in use as early as 1000 B.C. This improvement, no doubt, came from the Near East, where these primitive devices, in all probability, preceded the Roman lamps. Olive and nut oils served as fuels.

The ancient lamps of the Greek and Roman times were made of pottery and bronze. For a period of about one thousand years practically no improvement was made in their effectiveness as light givers. In artistic design the lamp underwent many changes, since the Greek craftsmen were far too ingenious and artistic merely to reproduce year in and year out the same patterns. The same holds good of the Roman artificers who carried on the traditions of their predecessors. Changes were made in the form of the beak; the use of handles or pedestals was a development; but the fundamental idea of the lamp was not changed except for the covering of the receptacle. Sometimes the number of spouts was increased to two, seven or even sixteen, and were skilfully contrived to have a place in the scheme of design.

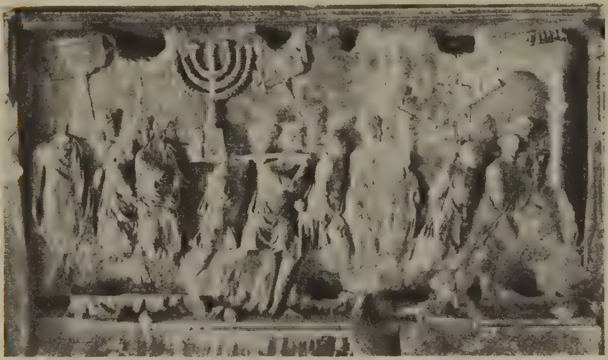


FIGURE 7—The Arch of Titus at Rome shows by carvings in stone the spoils that were taken from the Temple at Jerusalem after its capture by the Roman Emperor. Here we see the seven-branched candlestick of gold.

A very elaborate and beautiful Etruscan lamp, believed to date back to the fifth century B.C., was found in 1840 at Cortona. In the upper surface is the head of Medusa, while the sixteen spouts are decorated alternately with a satyr and siren, between them are masks of the river gods.

Records of one or two interesting customs which the old Greeks and Romans observed in connection with lamps have been handed down to us. Men used to honor their dead by placing lighted lamps with incense on their tombs. A New Year's gift sometimes took the form of a lamp.

In the upper part of the picture in Fig. 6 is shown a very interesting old Roman lamp, which dates back to 100 B.C. This lamp, with two spouts for wicks, has decorations which depict Eros, the Greek God of Love. It is of terra cotta and was discovered in a Roman palace while making excavations on the site of the ancient city of Carthage. The other examples in Fig. 6 include an ancient spout lamp of the eighth century A.D., and another pottery lamp which was also found in Carthage, discovered in the tomb of the early Christian martyrs, near the spot where St. Cyprian was beheaded. This lamp is of the fifth century A.D.

Because of the fragile character of the clay lamps, methods were devised for glazing them, and later came lamps of bronze, iron and other more durable materials.

A logical improvement in the lamp whose wick protruded from the side is seen in the spout lamp. This idea took on many forms, and was many centuries in developing. The most attractive of the spout lamps were Italian and seemed to have their origin in the three-spout pottery lamps or hanging lamps of the Romans.

The "lucerna" was one of the most interesting types. It was a small covered bowl-like receptacle for holding the oil on which to float one or more wicks. These protruded from spouts somewhat like those of a teapot. There were bronze hand lamps used on tables or pedestals, and lamps with chains to hang from brackets or from the ceiling. The "lucerna" on the rod is the old classic form, and is shown in Fig. 12.

During the sixteenth century hanging lamps were numerous. The most beautiful ones, for the sanctuary, were fashioned of silver, bronze or brass. Their contours were very similar, usually vase-shaped, varying from narrow necked, round bellied forms to shallow basins highly ornamented with Renaissance motifs. The sixteenth

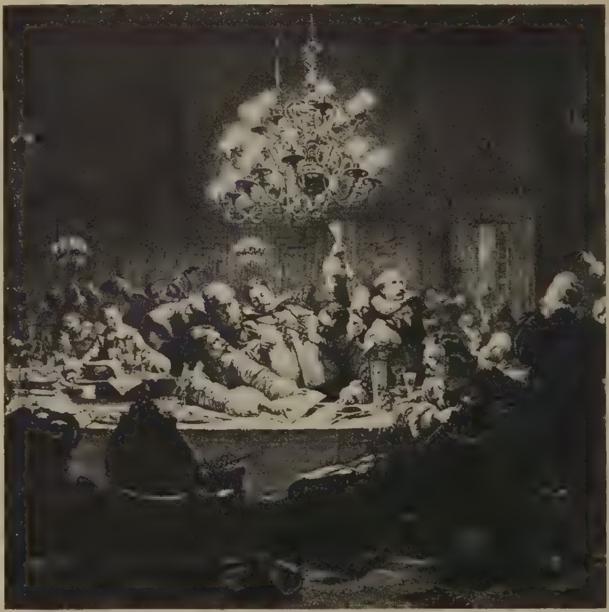


FIGURE 8—This scene of Wallenstein and his Generals at banquet illustrates the effectiveness with which candles were used for illumination in the early 17th Century.

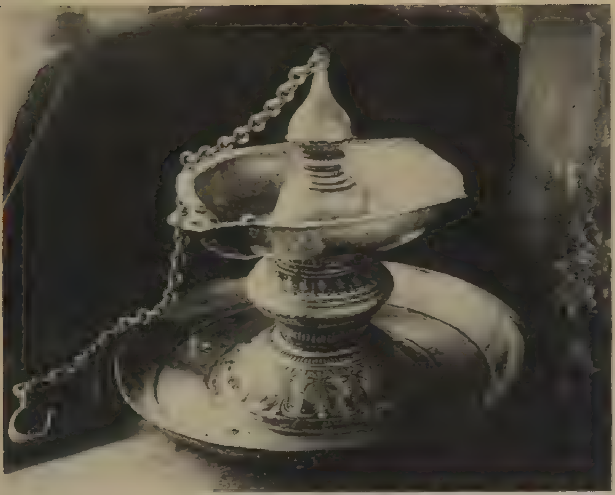


FIGURE 9—A silver hanging lamp from India which burned vegetable oil.

century lamp presented an important link between the lamp and the chandelier, inasmuch as the bowl of the lamp was frequently surrounded by branching candle sockets, as in the design of the "lampadario." These lamps were of the float-wick type, which was, no doubt, introduced into Europe with the Moorish conquest of Spain. Many were superb in workmanship and elaborate in construction. It was one of this type which inspired Galileo with the principle of the pendulum, as he watched it swinging in the cathedral in the historical Italian city of Pisa.

An interesting example of the hanging type of float-wick lamp is shown in Fig. 12. This lamp is known as the "lampada," and is of seventeenth century silver.

The candle, of all the artificial lighting devices that have been produced by man, has had the longest recorded history. The first candles were made of tallow and animal fats, and were in existence long before the Christian Era.

We find very specific instructions in the twenty-fifth chapter of Exodus for the making of the golden candlesticks for the Tabernacle. When the Roman conquerors took possession of Jerusalem, among the treasures taken from the Temple was the golden candlestick from the altar. Fig. 7 shows a portion of the triumphal arch of Titus in Rome commemorating this incident.

The direct ancestor of the candle was the taper, which consisted of a waxed rod burning in a vessel like a lamp, or wound in the form of a coil. The candle had many obvious advantages over earlier light sources. It could be easily made, stored for future use, and was conveniently portable. However, the candle did not begin to become a popular source of illumination until about the twelfth century.

The use of candles was dependent upon the state of human culture in the country and the supply of animal fat or vegetable wax, as only a limited number of materials may be used for candle making.

Until what might be called modern times, candles were made by hand, first by dipping and redipping a twisted wick into melted tallow or by molding the wax in forms of tin or iron. Every household was equipped with molds of various sizes. In many communities there sprung up a new trade, that of the chandler.

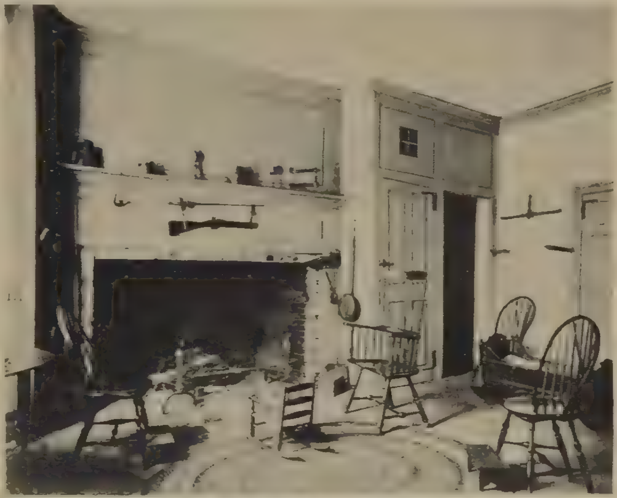


FIGURE 10—Typical interior of Colonial America. The famous "Betty" lamp hangs at the fireplace while other types of illuminating devices of that period repose on the mantel.

Street lighting in the early Colonial days was accomplished by placing candles in the windows of the homes. In 1679 a law was passed in New York providing that every seventh house should display a light at the end of a pole, thereby furnishing the illumination for the street. There is an account of a birthday party given by George

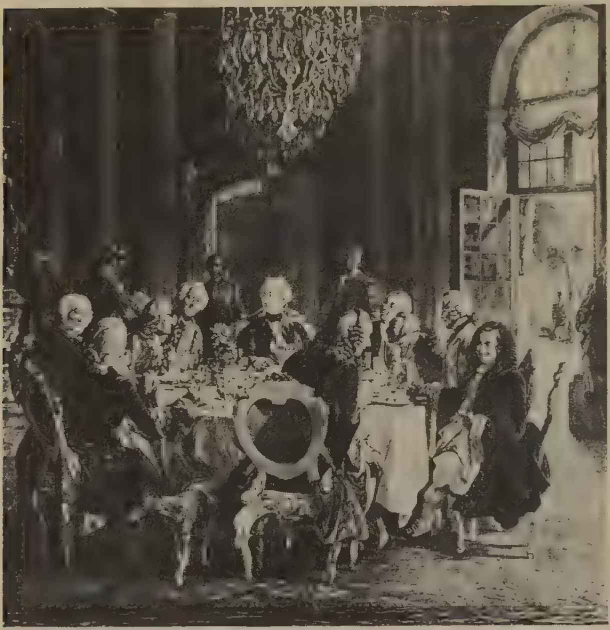


FIGURE 11—Elaborate chandeliers of crystal were developed by the French, the prisms reflecting the bright candle light. This festive scene shows Frederick the Great at Sans Souci.

Washington at which two thousand candles were used. The record of the time states that the room was brilliantly lighted, yet with a soft and agreeable quality.

Holders for candles were necessarily invented. The earliest types were pickets or spikes on which the candle was stuck. Later a socket holder or candlestick was devised, and, after having been employed for centuries, is still in use.

Candle holders have a fascinating history. They reflect the culture and artistic attainment of the peoples. They were made in a wide variety of shapes and styles, of simple or elaborate design, to suit their use in the workshop and the home.

We find on exhibit in museums examples in wood, unglazed pottery, glass, silver, brass, pewter and wrought iron. First came single candlesticks, then followed multiple holders—candelabra, chandeliers for candles, lanterns, devices for protecting the feeble glow from boisterous winds—all exhibiting the handiwork of the maker. At various periods the greatest artists of the time were employed in the making of designs.

The candle of the old days produced considerable smoke, and it was necessary to trim the wick at various intervals. When it was discovered, however, that sperm whale oil could be used for making candles a distinct advantage was gained and improvements were made, so that the snuffing of the candle and wick cutting were unnecessary.

In Colonial America, when materials for candles were not available, a primitive oil pan with a floating wick was used. This was known as the "Betty" lamp. The oil pan, which usually was of wrought iron, was covered and equipped with a hooked rod for suspending. As shown in Fig. 10, these lamps were used at the fireside, as they were evil smelling things at best, and were placed near the chimney where the gases could escape.

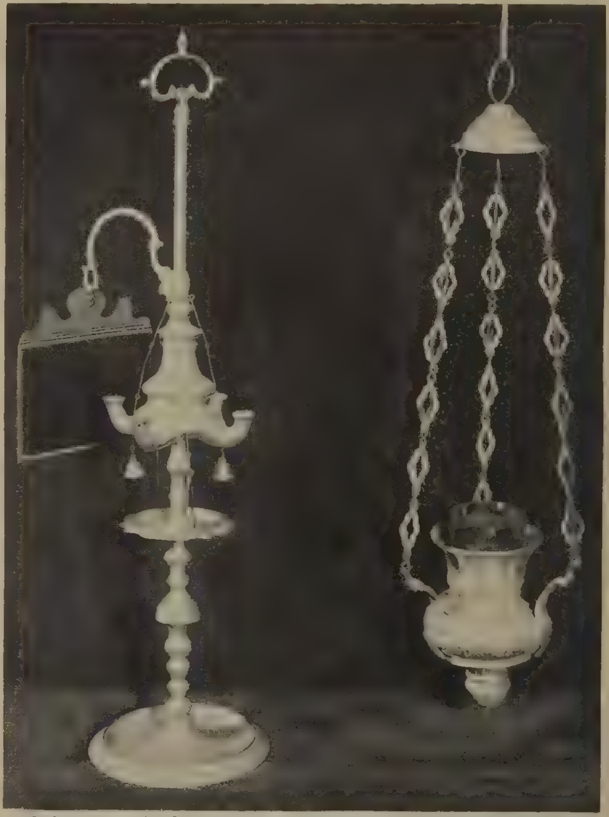


FIGURE 12—At the left is the Lucerna or Venetian stand lamp. At the right a float wick lamp of silver known as the Lampada.

In the logical course of development the lamp with a single wick was destined to make its appearance, and the opportunity for this came with the discovery of petroleum in 1859 by E. L. Drake, of Pennsylvania. This proved to be a highly desirable illuminant after it was refined.

The lamp for the burning of kerosene had a closed receptacle, and carried a wick in a tube leading directly to the center of the oil container. The introduction of a chimney enclosing the flame brought about a higher degree of steadiness. The making of "coal oil" lamps, burners and chimneys became a great industry. The lamp was very popular, but it was short-lived as a general means of artificial ilumination, giving way in a few years to the electric lamp.

Shortly before the days of kerosene a patented fluid, known as "camphene," made of a mixture of turpentine and alcohol, was used in preference to whale oil. Its popularity resulted because it burned without residue in a chimneyless lamp. Its explosive and volatile character caused it soon to be replaced.

No doubt the oldest scientific method of artificial illumination is that of gas lighting, which had its origin less than one hundred and fifty years ago. Coal gas was first used as an illuminant by William Murdock, of England, in 1779. A few years later a Frenchman by the name of Lebon also created a sensation by lighting his home in Paris with gas. It was not until 1847, during the administration of President Polk, that the White House was changed from candle lighting to gas.

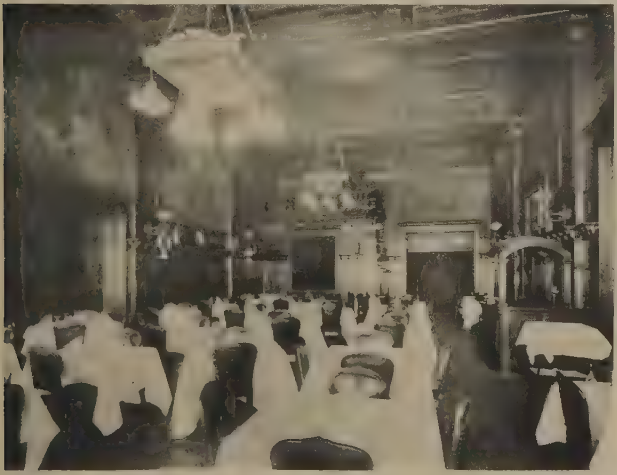


FIGURE 13—The "Old Dutch Room" in a city hotel. Showing a type of lighting fixture that developed after the introduction of the incandescent lamp.

Lack of purification delayed the popularity of gas until the latter half of the nineteenth century.

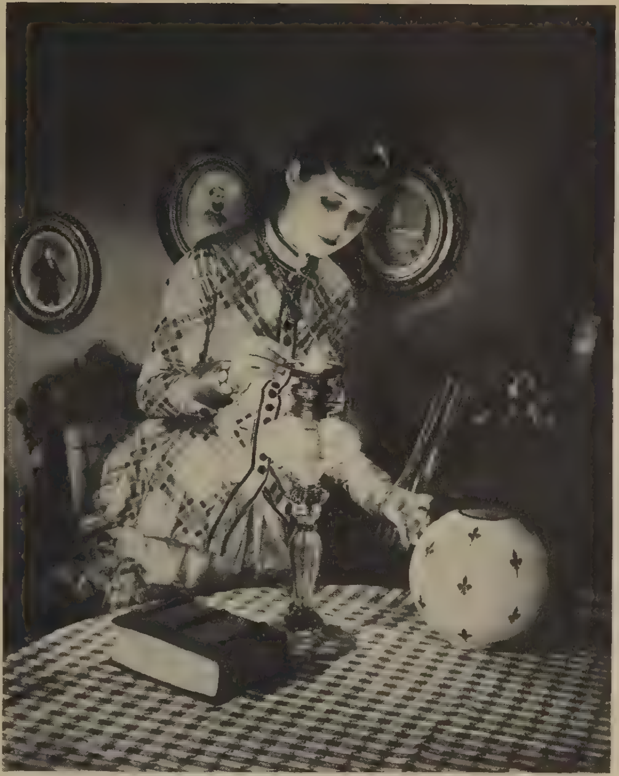


FIGURE 14—The kerosene lamp of our forefathers gave a light of very agreeable quality. It was not used as an illuminant until 1859, when Drake discovered oil in Pennsylvania.

The old batswing and fishtail burners were universally discarded when Welsbach, in 1885, produced a mantle of cotton fiber chemically prepared so that it might be lighted to incandescence. But gas as an illuminant, like many of its predecessors, gave way to a new source, a source radically different, safer and more convenient.

We have seen that from the earliest times until the last part of the nineteenth century man has depended upon burning materials for lighting. An interesting fact that few of us realize is that the first departure from the use of a flame for illumination purposes was made when different types of electric lamps came into use. The first commercially successful incandescent lamps were introduced by Thomas A. Edison and Sir Joseph W. Swan, and consisted of a filament of carbon enclosed in a small glass globe from which the air had been exhausted.

Although electric lamps had been used experimentally before this time, they were not practical; not only because they were not perfected, but because no suitable and adequate supply of electric current was available.

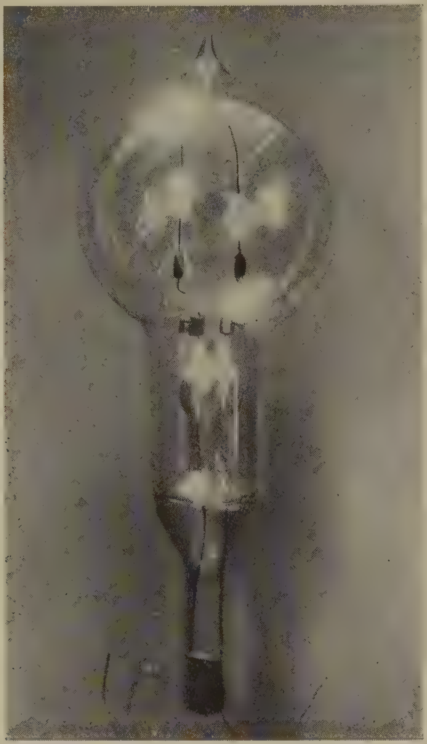


FIGURE 15—The incandescent lamp of Thomas A. Edison perfected October 21, 1879, and which has developed into our present day electric lighting sources.

Before 1800 electricity was more or less a plaything. Scientists were experimenting with it and studying its effects; but it was not until the dynamo was invented that electric lighting was made a commercial possibility.

Many failures resulted in the early experiments to produce an incandescent lamp. Finally in 1879 Mr. Edison produced a lamp which burned continuously for forty hours, and ushered in a new era in the history of illumination.

We have seen that artificial lighting is one of the oldest of the arts, and notwithstanding the great number of centuries man has been striving to improve it, it has remained the same in principle until a comparatively short time ago. Flame was the single source of illumination used by our ancestors. The only development was in the method of obtaining the flame. For ten thousand years artificial lighting remained practically at a standstill. There has been more progress in the last fifty years in the developing of the lighting art than through the previous fifty centuries.

Our modern lighting methods, when viewed against their historical background, stand out very vividly, and enable us to appreciate the many benefits that we are receiving that were not enjoyed by our ancestors. Furthermore, the great possibilities that still lie ahead of us are suggested in the future development of the art of illumination.

PART TWO

THE STORY OF CURTIS LIGHTING

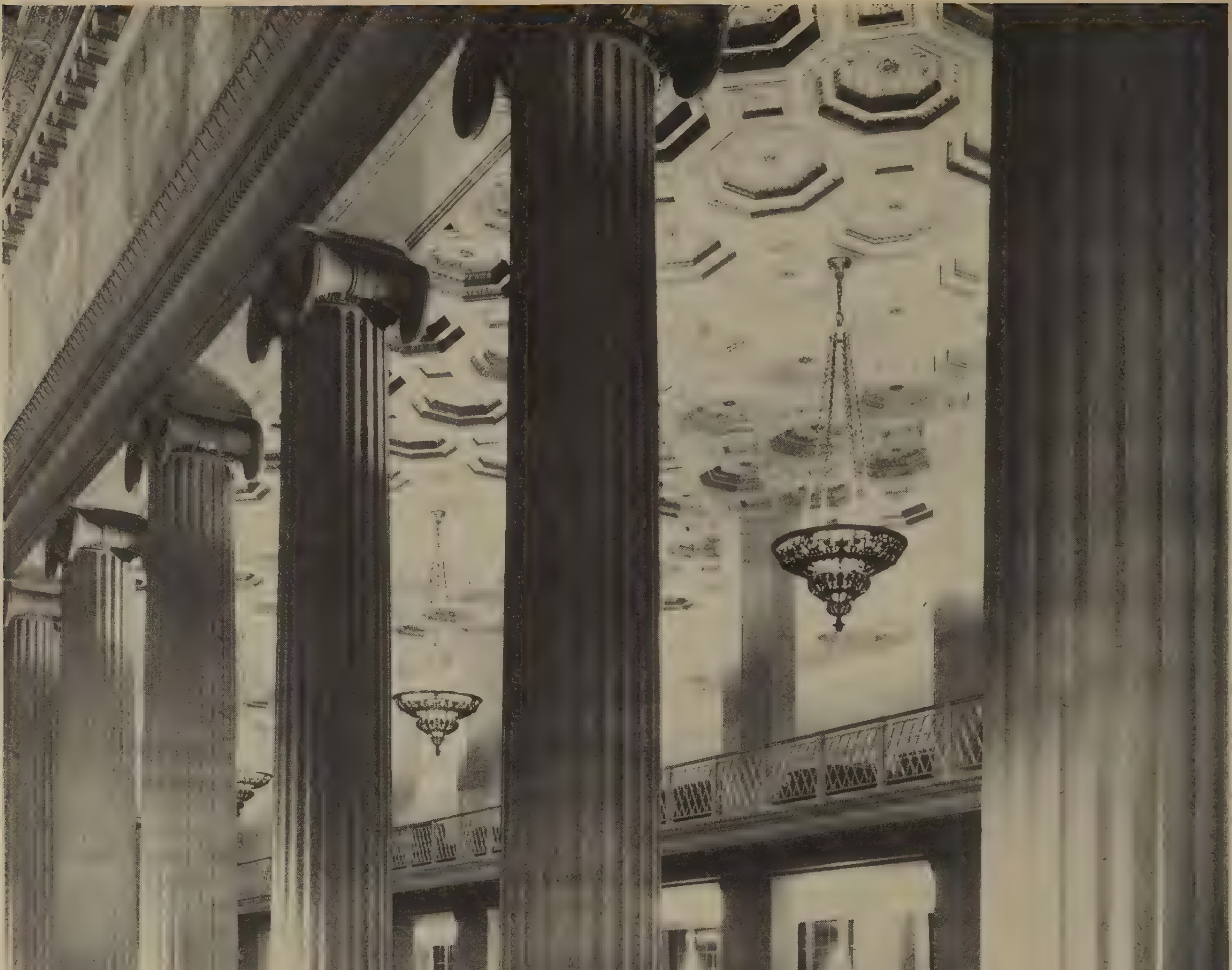
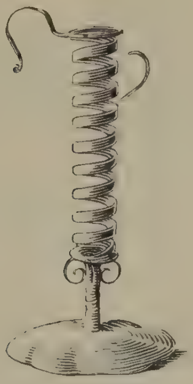


FIGURE 16—Main banking room of the Continental Illinois Bank, Chicago. Graham, Anderson, Probst & White, Architects. The beauties of this classical interior are revealed by indirect illumination. The luminaires of bronze contain X-Ray silvered reflectors.



EVERY industry, art and profession from time to time has the placid movement of its progress agitated by some surprising innovation. An idea, a method or invention is rushed forward by its champion to bring about some revolutionary turn in the procedure of affairs. The lighting industry has been no exception to this, and in looking back over the past fifty years we can see two distinctly revolutionary changes that have marked important epochs in man's use of artificial illumination.

The first was brought about by Mr. Edison in the perfection of the electric lamp. This fundamentally new type of illuminant was referred to in previous pages. So much success was attained in the scientific development of this novel lighting source that soon the age of blinding light was ushered in. Man by his own ingenuity had produced a giant illuminant, powerful enough to shed a radiance that was destined to revolutionize the economic conditions of life, yet so powerful as to strike brutal blows with the cutting blade of glare, menacing to the eyesight of man and threatening, by an enormous tax on his vitality, to counteract the great benefits that were intended for him. There was great danger that we were being conducted from darkness to discomfort, rather than from a condition of darkness to light.

The development of the tungsten lamp was the beginning of the end of glare, and marked the introduction of the era of light control. This improvement increased the brilliancy of the lamp filament beyond the powers of endurance of the human eye, thus itself furnishing the incentive for the elimination of glare from artificial lighting by proper restraint in its application.

Like a people oppressed, man, both consciously and unconsciously, endured the insidious onslaught of glare for many years, and it was under these conditions that the second revolution in lighting has its origin. The use of the unshaded electric lamp became so general that in 1898 the oculists of London petitioned Parliament to pass laws against these exposed sources in streets, shops and offices. It was thought such lighting would soon result in serious injury to the eyes.

The second radical change was the revolutionary use of the new illuminant. There arose a leader, a radical, the arch enemy of glare, a man of constructive ideas, with the temerity to suggest that the incandescent lamp, which had developed from the invention of Mr. Edison, and which had rocked the world with its wonder twenty years before, be hidden from view, completely concealed from the gaze of the human eye, and its radiance be controlled and utilized so as to put the light where it was most useful and needed.

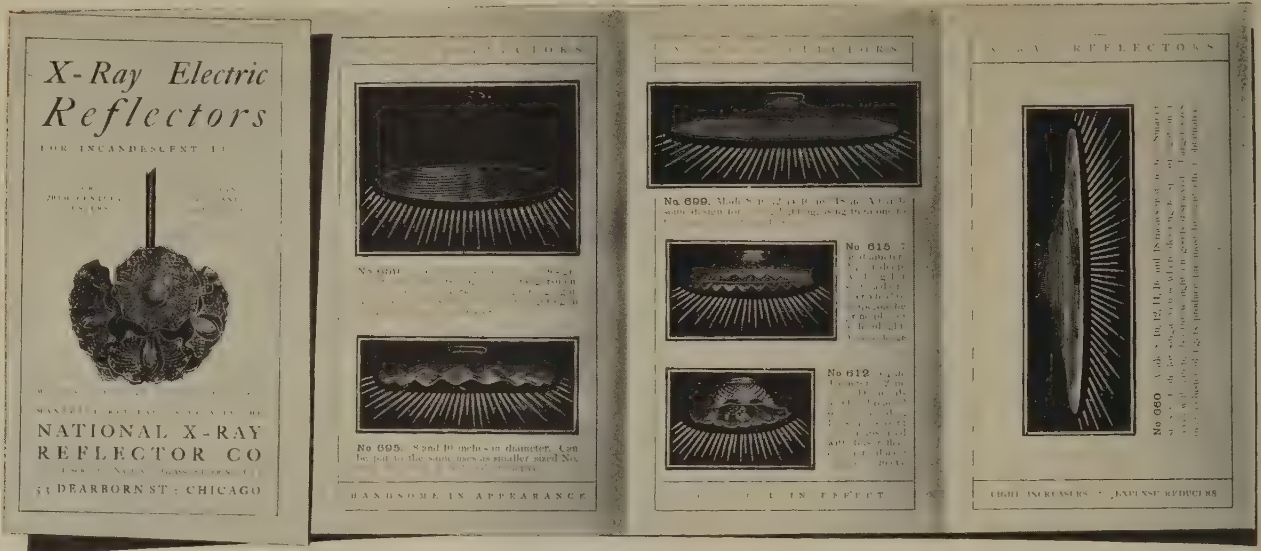

X-Ray Electric Reflectors
FOR INCANDESCENT
NATIONAL X-RAY REFLECTOR CO
DEARBORN ST : CHICAGO
No 695. 8 and 10 inches in diameter. Can be put to the same uses as smaller sized No.
HANDSOME IN APPEARANCE
No. 699.
No 615
No 612
IN EFFECT
REFLECTORS
No 660
LIGHT INCREASERS · EXPENSE REDUCERS

FIGURE 17—This circular was the first published catalog of X-Ray reflectors, issued many years ago by Curtis Lighting, Inc., showing types of "shades" offered to the public for light control. The organization was then known as the National X-Ray Reflector Company.

This courageous suggestion was no idle fancy, but proceeded from a definite conviction of Mr. Augustus D. Curtis, of Chicago, whose many innovations in the field of practical lighting application have resulted in immeasurable good by increasing man's seeing comfort. The chief objection lay in the fact that light, which we possess in abundance, was not adequately controlled; that it was not performing its most potent functions. It is true that in some few restricted fields satisfactory attempts at control had been made as, for example, in optical projection, in the lighthouse for the seacoast and the control of daylight by means of prisms; but, strange as it may seen, very little had been done to apply fundamental principles of light reflection to the great and increasingly important problems of illumination.

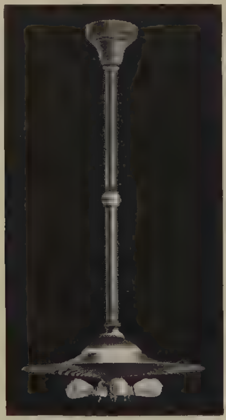


FIGURE 18—An early type of cluster lighting fixture produced by the Curtis organization, utilizing one of the large flat reflectors shown in the illustration above. Now lighting science dictates that each lamp shall have its individual reflector.

As if by some predetermined arrangement at this critical time, Mr. Curtis was approached by a gentleman who had for many months been experimenting with a new reflecting device in a modest laboratory, where the work bench consisted of an old billiard table, and an antique trunk served as a storehouse for his supplies and chemicals. It was Everly L. Haines, the poor but justly proud inventor, who had found as a result of his toil a one-piece silvered glass reflector, of high reflecting properties and permanent quality, for the incandescent lamp. The inventor, who had not the means of broadly marketing his idea, was looking for some one with faith and vision, some one who could visualize as he did the latent possibilities in that innocent looking piece of molded silvered glass. He was not long in the seeking, for it was Mr. Curtis who recognized in this simple device an idea that could be developed into an effective weapon in waging his campaign against glare and wasted light. When a new organization was formed to develop and market this novel device for the control of the radiance from incandescent lamps, it was given the rather imposing name of National X-Ray Reflector Co.

Mr. Curtis, assisted by Mr. Arthur Morgan until the untimely passing of this valued co-worker, organized the details of manufacture, sale and installation with masterful completeness and extraordinary vision. New shapes were designed to multiply the uses and value of the invention, and a ceaseless stream of ideas and suggestions was carefully investigated and tried out. In time the X-Ray reflector reached its present superiority in control and its world-wide demand.

It may be noted, as a matter of record, that the first X-Ray reflectors were used for the lighting of a shop window display in Chicago in 1897. The Washington Shirt Company haberdashery installed them, and so wonderful and unusual were the results that several were used inside of the store as well. The success of this trial led immediately to other installations, until the "Show Window Searchlight," as it came to be called, soon found universal use, and was generally considered as standard for show window lighting.

It is interesting to compare the first published descriptive circular of X-Ray reflectors with the present voluminous catalog and data book of the products of Curtis Lighting, Inc. Before the idea of the concealment of the light source was made a definite and fundamental principle of the business, X-Ray reflectors took on the forms that are shown in Figs. 17, 18 and 19—flat shallow shades more decorative than useful for light control.

While the first applications of the new reflector designs were somewhat crude, as judged by our present standards, they were, nevertheless, revolutionary. The fundamental idea of hiding the lamp began to manifest itself definitely in the new contours. For example, the "Helmet" and the "Beehive," two of the rugged old "musketeers" of the X-Ray brigade, pictured in Fig. 20, show the deep, enveloping style of design that was adopted to hide, as completely as possible, the brilliant filament of the lamp. The "Helmet" was produced for the specific problems encountered in shop window lighting, while the "Beehive" found its widest application in industrial and commercial lighting for factories, garages, printing shops, gymnasiums, etc.

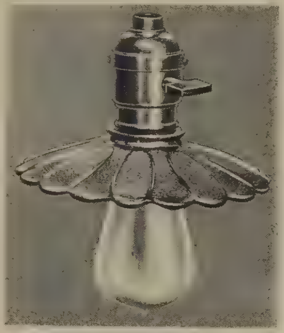
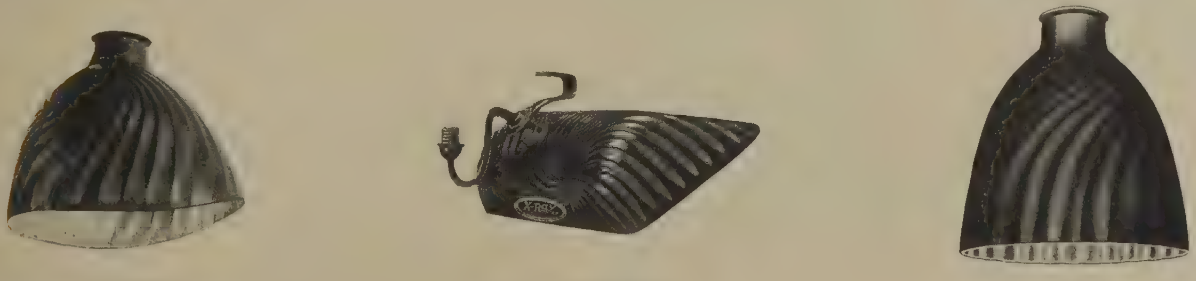


FIGURE 19—A decorative reflector extensively used in the days of the carbon lamp. The sparkle of its silvered surface attracted all eyes.

The most strategic movement in the campaign against the common enemy, "Glare," was made in the discovery and introduction of indirect illumination in October, 1908. It was in the home of Mr. Curtis, in Chicago, that the first public presentation of practical indirect lighting was made before a joint meeting of the local section of the



The Helmet *The Pokebonnet* *The Beehive*

FIGURE 20—These "Three Musketeers" of the X-Ray reflector brigade, popular twenty years ago, fought the early battles for better lighting. They revolutionized lighting for show windows and other applications. The "Poke Bonnet" was the first reflector design to be produced especially for the scientific illumination of shop window displays.

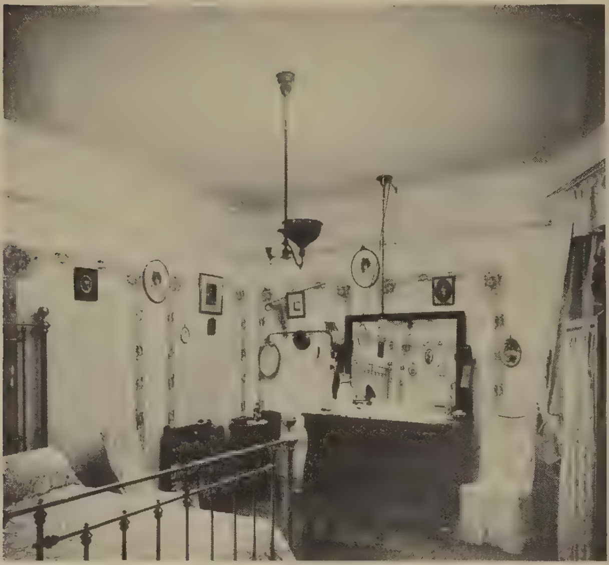


FIGURE 21—The original indirect lighting unit was attached to the chandelier of a bedroom in the home of Mr. Augustus D. Curtis and used as a part of the first practical demonstration of the new system when it was formally introduced to the public in October, 1908.

Illuminating Engineering Society and the Opthalmological Society. This was the first demonstration of directing light to the ceiling by powerful silvered reflectors, thereby obtaining a soft, diffused illumination from totally concealed sources. It was a memorable and most significant moment in the history of modern lighting.

One of the rooms used in the demonstration of the indirect illumination at this time is pictured in Fig. 21, and illustrates how the existing two-light gas and electric chandelier was converted by the application of an indirect lighting "adapter" into a device for "continuing the daylight," and simulating more closely than had ever before been done in all artificial lighting practice the agreeable and eye-comfort quality of natural light.

Commenting on this meeting, that outstanding technical publication, the "Electrical World," stated editorially: "The meeting at Mr. Curtis' home was, perhaps, the inception of the great movement of the present day for eye comfort and the conservation of vision by concealing light sources."

Those attending the meeting were amazed at the diffuse and soft daylight quality of the "inverted" lighting, and from that time forward light and illumination were no longer synonymous. Light was the cause, and illumination became the result. The possibilities of an art as well as a science of illumination began to dawn upon the consciousness of those present.

The new and revolutionary system was not without its critics. Many of those skilled in the practice of illumination condemned the idea of lighting the ceiling as rash nonsense, economically absurd, as something that had no fundamental basis, and surely would have no acceptance on the part of the general public. Strange to say, many of those selfsame critics are today the most ardent champions of the Eye-Comfort System of indirect illumination, as it was characterized. However, no rapid, startling strides were made in the advancement of the new method in lighting. Demonstrations were made in offices, churches, theatres, and other public buildings. There was much anxious waiting for the favorable turn in public opinion that finally came as a reward for many sleepless nights of patient testing to prove the soundness of the principles of lighting from concealed sources, a principle now accepted as basic in modern lighting practice.

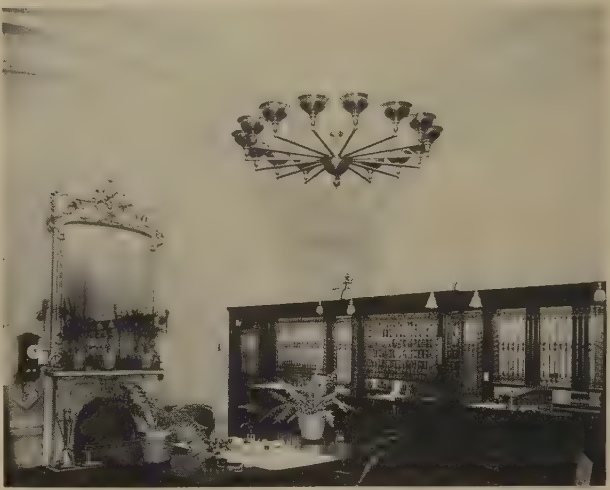


FIGURE 22—Office of the Sergeant-at-Arms in the Capitol at Washington, D. C. One of the early installations of commercial indirect lighting adapting metal spinnings, containing X-Ray reflectors, to the existing chandelier.

It is a well known fact that a sense of humor

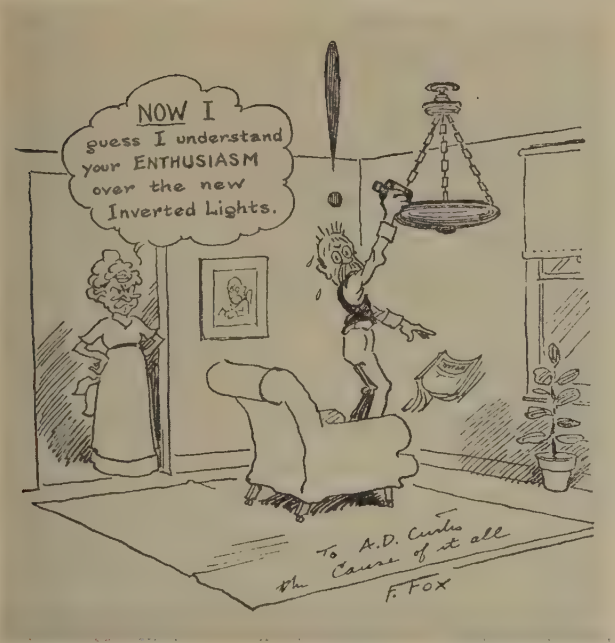

NOW I guess I understand your ENTHUSIASM over the new Inverted Lights.
To A.D. Curtis the Cause of it all
F. Fox

FIGURE 23—Cartoon by the famous artist, Fontaine Fox, illustrating how "inverted lighting" was in its early days the subject of much good-humored jesting.

is a most valuable asset to anyone engaged in modern business. The promotion of indirect illumination had its humorous side, and as a typical example of the hundreds of jests that were based on the new system the cartoon in Fig. 23 is included. Here we see a sketch by the famous cartoonist, Fox, which through a syndicated service appeared in many of the leading newspapers of the United States. The original was presented by the artist to Mr. Curtis, with an appropriate dedicatory inscription.

At one time during the early promotional work, Mr. Curtis, in one of his characteristically jovial moments, founded "The Universal Anti-Glare Society," a society that had no application blank, no initiation fee, and no membership dues. To belong to this novel association one needed only to recognize the wrong and injurious practice of exposed direct lighting units for interior illumination, and to protest against the continuance of such practice to those responsible for the conditions. Hundreds of thousands of people were unconsciously members of this Society. Every headache caused by brilliant exposed lighting units made a new member. The certificate of membership was sent to hundreds, and if all the members could have united in their protests, a tremendous and rapid improvement would have been made in living and working conditions.

And so, from modest beginnings through the struggles of organization and promotion, the "X-Ray Family," as it is called, grew to full stature. Outgrowing from time to time its office and manufacturing quarters, adding branches and establishing a manufacturing plant in Belgium, known as Curtis Lighting—Europe, developing many types of reflectors and accessories for the "harnessing of light," and adding a variety of departments to serve the client. The organization has become known to the architectural and lighting professions (with which it cooperated to the fullest degree) as the "Clearing House for Lighting Ideas," the largest organization of its kind devoted exclusively to the promotion of engineered illumination.

From the date of the establishment of the company to the end of the year 1923, the Curtis interests in the lighting field comprised the National X-Ray Reflector Company, of Chicago, the X-Ray Reflector Company, of New York, and the Luminaire Studios, Incorporated, of Chicago and New York. A grouping of these various interests was desirable from many standpoints. Beginning

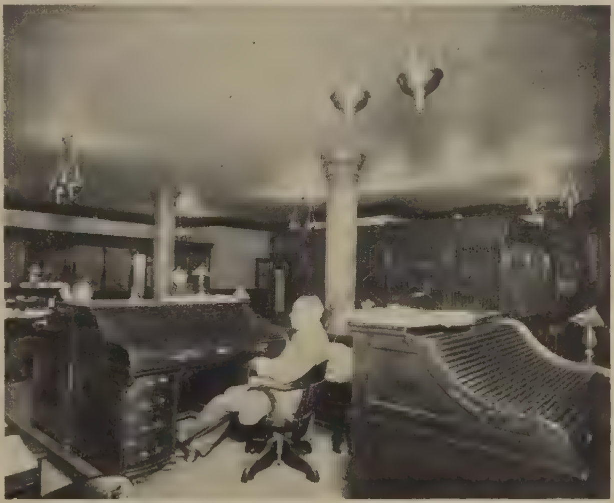


FIGURE 24—An office installation employing the famous "Scales of Justice" twin light X-Ray indirect fixture, one of the types that did faithful service in the pioneering days for better lighting.

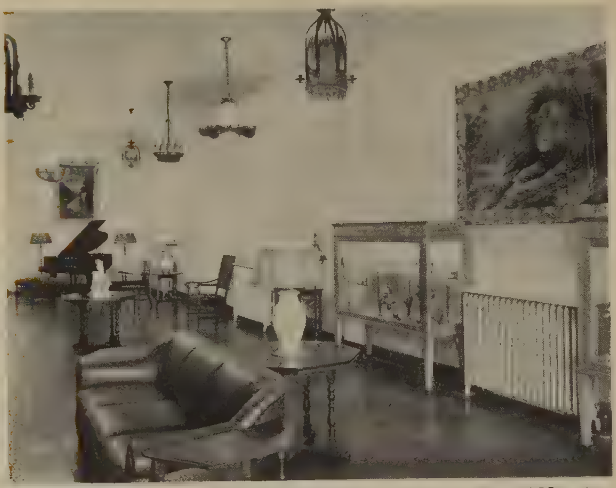


FIGURE 25—A view of the display rooms of the "Clearing House for Lighting Ideas," the main office, factory and laboratories of Curtis Lighting, Inc., Chicago, where light is harnessed and the products of the Luminaire Studios are displayed.

with the new year 1924, they were all combined under the name Curtis Lighting, Incorporated, a name of significance because it combined the idea of a personality with that of the nature of the activity in which the organization was engaged. Thus, while the name of the company is comparatively new, the organization is old in experience and tradition, representing many years of cumulative knowledge and experience in light control.

For more than a quarter of a century Curtis Lighting has set itself to the task of light control and elimination of glare, the most harmful element in modern lighting; and in this conquest it has always maintained a strict policy of cooperation with the architects, the electrical jobber, the contractor, dealer, and the central station, all of whom have come to consider Curtis Lighting products and service as most vital factors in the construction and equipping of modern buildings.

The introduction of correct practice in lighting has involved and will in the future incorporate a campaign of education, not only of the masses, but the preparation of information for hundreds whose business it is to supply the consuming public with lighting devices. This educational work has included the preparation and distribution of authoritative literature giving data, principles and illustrations of the best illumination practice and equipment. Thousands of architects, engineers and lighting men find this information valuable for continual reference.

To properly serve its clients, Curtis Lighting has found it necessary to carefully select and train all of its sales engineers and representatives; hence with each year a group of men is selected from the various colleges and given a special course in training in all of the departments of the organization for a period of a year. The broad training that these students receive fits them to represent the organization and serve the client.

Our aim in the lighting business is to devise and perfect new ways by which light may be harnessed. Light is the servant of mankind. It can be made a much more faithful servant. Continual research and study to bring it under perfect control is our problem.

The whole story of Curtis Lighting may be summed up in this "The Curtis Creed:"

"To bring brighter blessings and bigger benefactions into all lives through light; to make the hum of industry throat a happier song; to make the wheels of commerce roll more smoothly along; to create hallowed harmony in such sacred precincts as church and home; to take glare from the rays and to comfort the gaze, opening the eyes of the world to greater joy in seeing, through lighting that is correct, be it direct or indirect."

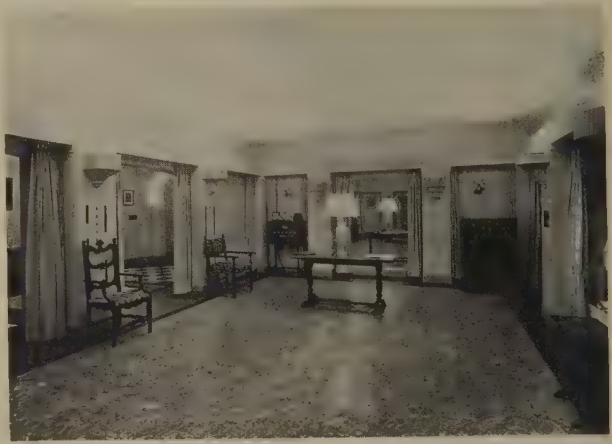


FIGURE 26—One of the rooms in the studios of Curtis Lighting in New York City, designed for the demonstration of practical methods in light control.

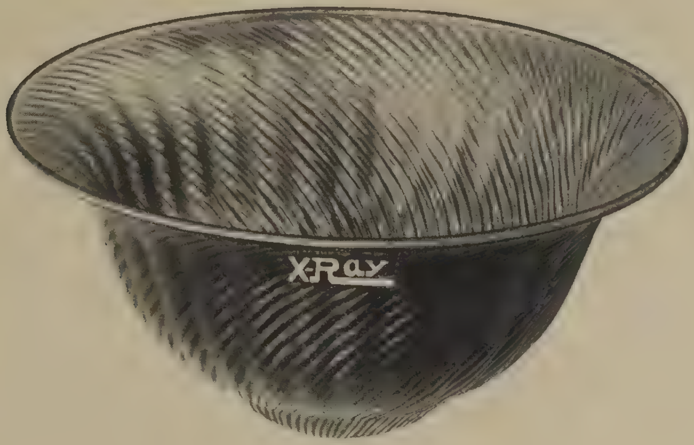


FIGURE 27—The X-Ray reflector, the sturdy and powerful accessory which forms the basis upon which all Curtis Lighting units are built, and whose qualities of endurance and high efficiency in light reflection have been responsible for the remarkable satisfaction of thousands of modern lighting successes.

The X-Ray Reflector

Although frequently hidden away in some structural element of the building, housed in a casing of metal, or, it may be, concealed within the enveloping body of an artistic luminaire, the sturdy and reliable X-Ray reflector exercises with exactness a precise control over the brilliant rays of light emanating from powerful modern lamps.

This reflector is the result of skill in glass making, expertness in scientific design of contour, extreme care in the application of its chemically pure coatings of silver and exterior finish. It is built to last for years under all service conditions, if not abused. It is made by processes that insure a uniformity of appearance, of quality and performance. Enduring character is molded into every part of the X-Ray reflector. There is a grace in its line, regardless of its purpose, whether for the industrial plant, show window, or the illumination of a cathedral. The dominating thought in the making of the X-Ray reflector is expressed admirably by the following quotation: "A genuine craftsman will not adulterate his product. The reason is not because duty says he shouldn't, but because passion says he couldn't."

Each reflector is made of one piece, blown of tough glass and, in the heat of the furnace, glazed so that dust will not readily adhere to its surface. Each X-Ray reflector is handmade, being produced by the glass blower one piece at a time. The pure silver reflecting element placed on the outer surface is backed up by a special process.

The glass used in the manufacture of X-Ray reflectors is of a particularly superior and diamond-like quality, resulting in an extreme brilliance in the reflecting surface. This brilliance is the measure of highest efficiency in reflecting power, the quality that has caused the X-Ray to be chosen and accepted by users as the "standard" silvered reflector.

The X-Ray reflector is designed to break up and diffuse the light rays of powerful incandescent lamps, thus eliminating all streaks and unevenness in the lighting. Molded into the reflector surface is a double system of patented radial and spiral corrugations, producing a remarkable smoothness in the lighting results. The physical laws of light control are utilized in the design of the reflector contour. Inherent in its qualities are substantial ruggedness, a carefully planned design based upon expert knowledge, and the requirements of practical performance in service. To produce reflectors of exact design for the many and varied requirements of artificial lighting, peculiar and unsymmetrical shapes are frequently necessary.

The X-Ray reflector is known to be the most powerful commercial reflector made, the most efficient for the directing and controlling of light. Scientists have discovered that a polished plate of silver will reflect more light than any other known substance suitable for lighting accessories. The X-Ray reflector most nearly approaches this ideal. The reflector retains its original brightness and efficiency indefinitely because of the special processes that are used in its manufacture. It has been found that the maintenance of installations using X-Ray reflectors is very simple. It is only necessary to use a dry cloth to remove any dust accumulations, and the original brightness is at once restored. The reflecting surface itself is never touched in cleaning, as one side is protected by glass and the other by the special backing.

The X-Ray reflector is a reflector with a personality. Mere numbers are not used for designation and for catalog purposes. Each important design is named as well as numbered, as, for example, the "Scoop," which was for many years synonymous with good show window lighting. Other characteristic names are the "Jumbo," "Big Boy," "Jove," "King," "Pup," "Jill," etc.

A great many reflectors have been designed in various sizes and shapes to meet growing demands. There is an X-Ray reflector available for every lighting need. Their use has been extended by methods of direct and indirect lighting into the various industrial, commercial and residential fields, in fact, wherever artificial illumination is required.

When a work of any description is acknowledged to be supreme in its field, it inevitably becomes the object of comparison. There is nothing unusual in this. It befalls any product which has won the reputation of being surpassingly fine. Invariably there are those who imitate and claim equality with it, and who seek to profit through its high repute; but in their efforts to duplicate the original, they neglect to duplicate the skill and artistry which give it distinction.

They succeed only in imitating the lesser details, the shell and semblance of the reality; they never attain to its deep, inner excellence. They are barred from reaching this goal by the natural law that the follower can never be the leader; that he who is content to tread in the leader's footsteps can never by any chance overtake him. The public, sitting in impartial judgment, is not deceived by unsupported claims, and does not accept them as a substitute for performance. The public knows that comparisons are never sought with the commonplace, but always with the best; and they serve only to confirm and strengthen allegiance to the leader.

Where the light source is concealed from the range of vision, where the light rays are controlled by directing them where needed without injury to the eye, and where reflecting efficiency is highest—there you will find the X-Ray reflector.

X-Ray
TRADE MARK REG.
Reflectors

PART THREE

ENGINEERED LIGHTING

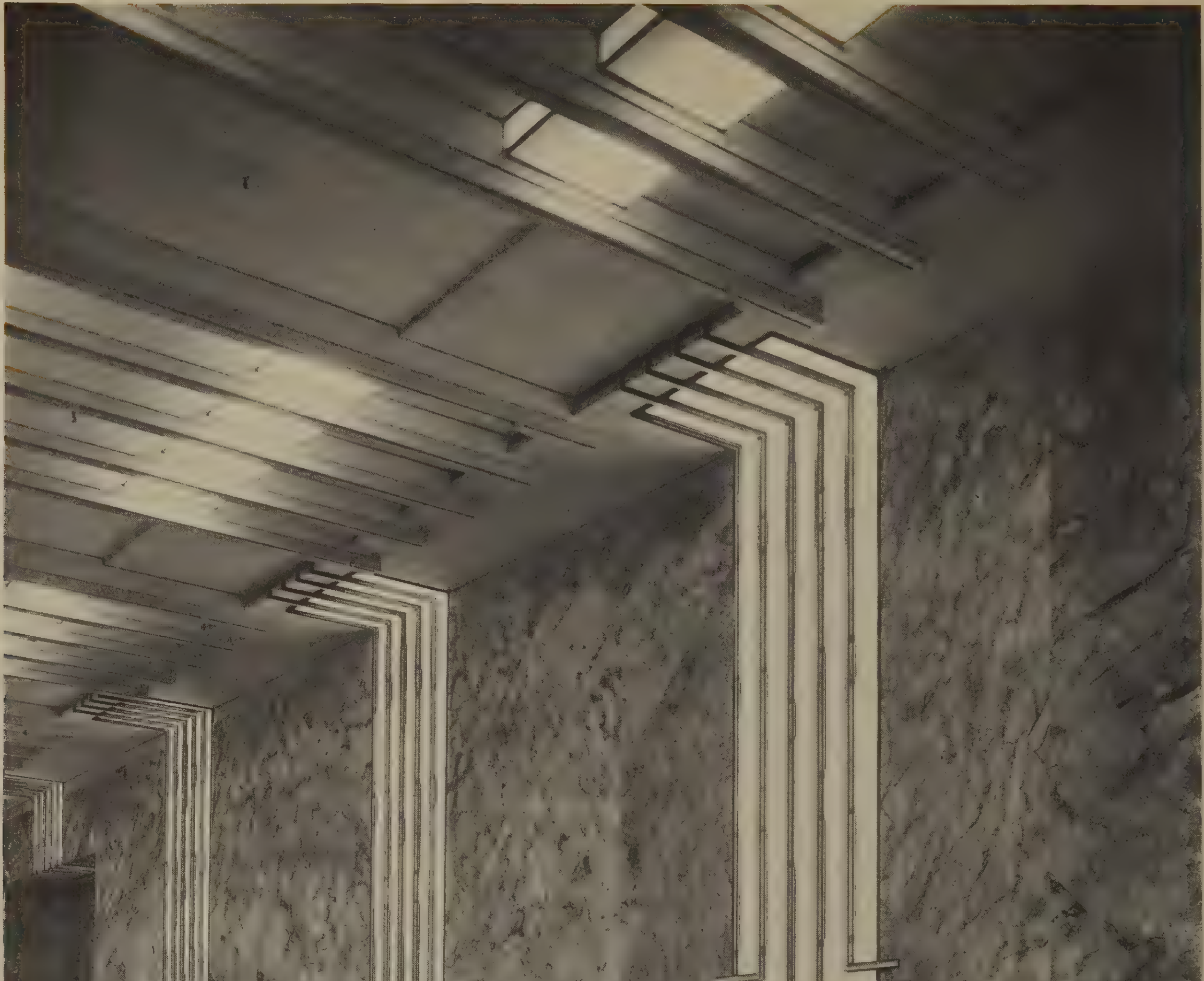
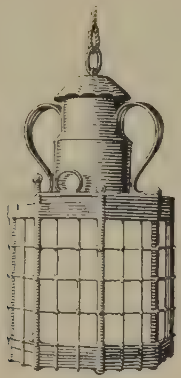


FIGURE 28—The main salesroom of Bullock's-Wilshire Building in Los Angeles, California. This outstanding example of engineered lighting and decoration in the Moderne is the work of Feil and Paradise, designers of store interiors. John and David Parkinson were architects of the building. All lighting is with X-Ray reflectors and diffusing glasses built into the wall and ceiling surfaces.



A SPECIALIST in the field of illumination, in fact any one whose activities include the specification of lighting plans and systems, any one who has the responsibility of advising in the use of means for producing artificial illumination, has much more to consider than is at first apparent from a superficial consideration of any given problem.

If it were a question of supplying just so much light, how simple and uninteresting the task would be! If the whole of lighting practice could be reduced to a set of rules supplemented by a few graphic charts and diagrams, it would never come to be considered as a fine art. It would cease to inspire us, and sooner or later we would steal away into other fields offering more of interest, variety and opportunity.

After many years of practice in this field, it has been found that the creation of good lighting involves a body of knowledge which equals, perhaps excels, in range and complexity the basis of any learned profession, involving besides the usual engineering equipment of physics, chemistry, mathematics and economics, some consideration of psychology, art and architecture, physiology and hygiene.

Although the lighting of a building is often, unfortunately, a series of compromises, just as in the case of the architecture, many errors may be avoided by keeping in mind a few fundamentals. Whether the interior is a modest office or a great cathedral, we have essentially the same kind of problem. To be more specific, all of our artificial lighting problems have in their final solution the proper merging of three distinct aspects or conditions. The first is that of utility; the second concerns the comfort of the eye; the third is the artistic balance of the various elements.

Three Aspects of the Lighting Problem

The utilitarian aspect includes such important items as providing sufficient illumination for reading, adequate wiring facilities and capacity, economy of operation, reasonable cost of equipment consistent with good design, efficiency in utilization of the light, simplicity and convenience, flexibility for the switching and the dimming of the lights when necessary, provision for easy maintenance of equipment.

The hygienic feature of the lighting problem requires first that the quality of the light be such as to provide for the comfort of the eye; that it be free from glare and strong contrasts; that the brightness of the lighting units be of low value; that the light be well diffused; that adequate shading of the light source be provided for eye protection and the conservation of vision.

The third important element, that of artistic balance, calls for a consideration of any symbolic features that might have an influence upon the character of the lighting installation or the artistic design of the luminaire; the influence of the architectural type should be studied, also the effect of the lighting upon the architectural treatment. Such things as color harmony, shadows, appropriateness and dignity all are phases in the artistic side of the lighting. Refinements in decorative lighting arrangements, and the producing of atmospheric or psychological effects by means of illumination call for special study.

It is our task to combine harmoniously and not in a discordant way these various aspects of utility, eye comfort and artistic consideration. Obviously we encounter in practice all manner of instances that require consideration of the above questions in varying degrees. For example, a machine shop in the industrial field requires first of all a uniform general working illumination. The artistic feature is not of much importance, while the hygienic aspect of the lighting is just as important as that of supplying the proper intensity.

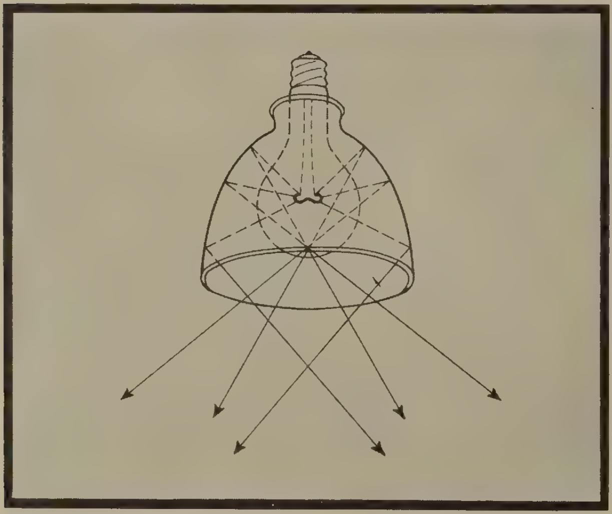


FIGURE 29—This diagram shows how by utilizing the physical laws of light reflection the powerful X-Ray silver mirrored reflectors harness the rays and shade the eye from the brilliant lamp filament.

On the other hand, in lighting the theatre the predominating requirement is on the artistic side. Uniformity of illumination is not so essential, and many times is sacrificed to the decorative arrangement of things. The efficiency of light utilization is not given as much weight as for the industrial plant, but here the essential element of eye comfort is still very vital. In fact, in practically no type of lighting installation is the importance of this item in any way reduced.

In the lighting of a store, for example, the three phases of utility, eye comfort and art enter into the solution of the problem with almost equal importance. The lighting level is usually high. The most comfortable seeing conditions must be provided for the customer, and the artistic design of the fixture or fittings used for producing the lighting effect should be in harmonious accord with the general furnishings.

Regardless of the type of installation or class of interior, whether it be hotel, bank, library, drafting room, restaurant, church, hospital or residence, the fundamental problem of the lighting engineer or others concerned with the planning of proper illumination is the merging in proper proportions the various phases that have just been outlined. By careful planning and attention to detail, light will give the magic touch that will produce just the effect that is desired, whether it be providing of rational lighting for the worker, or the transforming, revealing and accentuating of the magnificent detail of a beautiful architectural creation.

Utilitarian Requirements

In the control or harnessing of light we have for working materials lamps and their accessories. The lamp alone gives a quantity of what has sometimes been called "raw" candle power, which is not desirable to use unmodified. It must be controlled and properly directed, otherwise it is annoying, wasteful and inartistic.

Let us consider for a moment what might happen to a beam of light given off by a source if it were started on its way through space. It may continue to go on for ever and ever if not interrupted. It may be absorbed as it travels through the atmosphere. It may be reflected or changed in the direction of its beam. It may be refracted or bent out of its regular path. Furthermore, this beam of light might readily be subjected, in many cases, to a combination of the last three conditions. These latter are the conditions which govern the development of most of the equipment used with lamps, such as reflectors, shades, refractors, etc. It is our attempt to control artificial light that has brought about the development of the vast number and variety of accessories that are available for use with lamps.

When the first electric lamps were produced, soon after the invention of Mr. Edison, little attempt was made to control their brilliancy; and although they were very tolerable to the eye compared with our present day sources, they evoked much comment. It is interesting to read what Robert Louis Stevenson said about the early electric lamp when he encountered one unshaded forty-eight years ago at the "Figaro" office in Paris. He remarked that:

"In Paris, at the Figaro office, a new sort of urban star now shines out nightly, horribly, unearthly, obnoxious to the human eye; a lamp for a nightmare! Such a light as this should shine only on murders and public crime, or along the corridors of lunatic asylums, a horror to heighten horror. That ugly blinding glare may not improperly advertise the home of the slanderous Figaro, which is a backshop to the infernal regions; but where soft joys prevail, where people are convoked to pleasure and the philosopher looks on smiling and silent, where love and laughter and deifying wine abound, there, at least, let the old mild luster shine upon the ways of man."

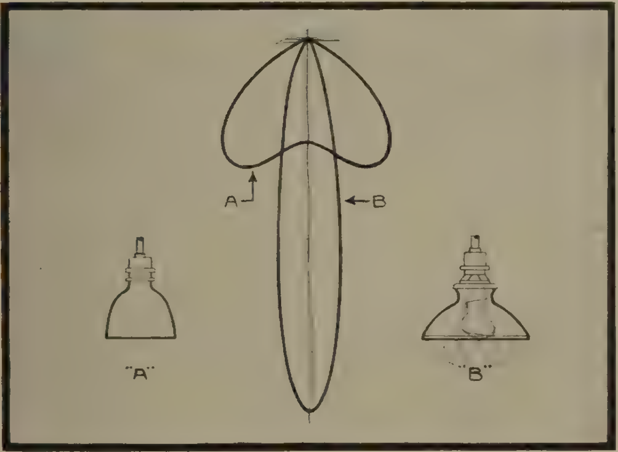


FIGURE 30—Extreme accuracy in the design of contour is responsible for the nicety in control of light by the X-Ray reflector. The two shapes A and B above are for the same lamp but exhibit totally different characteristics in their manner of distributing the flux from the lamp.

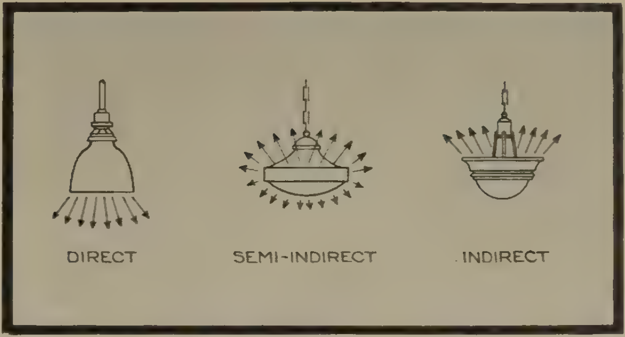


FIGURE 31—The three principal types of luminaires used in artificial lighting practice. The arrows indicate the relative direction of the rays from each.

Much progress has been made in the harnessing of light since Stevenson wrote the above lines. An entire science and art of illumination has been developed in the past few decades. Artificial lighting has been admirably adapted for our daily needs, our comfort, our business requirements, our work, our play and our worship. It may be emphasized in passing that the X-Ray reflector, which is described on page 31, and whose applications are the subject of this volume, has been one of the greatest agencies ever devised for the proper and rational utilization of artificial lighting and has played a large part in the revolutionizing of lighting methods. A suggestion of the manner in which light may be controlled is shown in Fig. 30, where two types of X-Ray reflectors, designed for the same lamp size, have totally different characteristics as far as their delivery of light is concerned. The curves in the center of the diagram are known as distribution curves and represent the manner in which the light from the reflector is delivered into space. "A," for example, indicates that the light is widely distributed, whereas "B" shows the rays confined to a concentrated beam.

In our attempts to meet all the various lighting conditions that are encountered, three principal methods have been devised for the illumination of interiors in general. These are roughly classed as direct lighting, semi-indirect lighting and indirect illumination.

In the direct lighting system the unit, which usually consists of a lamp and shade or reflector, emits the major portion of its light downward, in such a manner that it falls upon the area to be illuminated without reflection or redirection. This fundamental principle is shown diagrammatically in Fig. 31.

Semi-indirect lighting is a rather indefinite term, but is usually considered as a system in which the illuminating mechanism directs the light flux towards the ceiling or upper side walls, from which it is reflected to the working plane, while a considerable portion of the light is transmitted through the translucent body of the unit.

In the indirect lighting system practically all of the light is directed upward to the ceiling and again diffusely reflected over the entire room area. The ceiling in this case becomes the secondary light source. It is large in area and of low brightness, so that the system is particularly favorable for providing even illumination of a diffuse daylight quality and free from glare, since no bright area or source is visible.

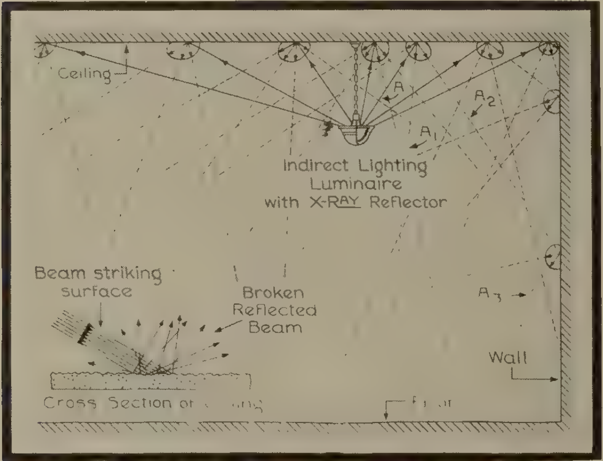


FIGURE 32—This diagram shows the principle of indirect lighting. The ceiling acts as a diffusing medium and breaks up each light beam into a series of rays, giving an illumination free from glare and strong shadows.

Indirect Illumination

Diffused, natural lighting has been and is the ideal of what is desirable to obtain by artificial means. Much of our daylight in offices is obtained indirectly from sunlight reflected from clouds, from the walls of buildings, trees, hills, and other things in nature. Very seldom do we work under the direct sunlight.

A recent bulletin of one of the large lamp manufacturers says: "When the sky is overcast with clouds we might move our desks outdoors and work under ideal lighting conditions, because shadows and glare are practically eliminated by the diffused light coming down from the whole sky. This latter, then, is a criterion for good quality of light for office work.

"Artificial light indoors offers the same range of quality as daylight outdoors. Harsh shadows and glare result from insufficient diffusion of light, while illumination of excellent quality for office work is obtained when the whole ceiling becomes the effective source of light, just as the whole sky becomes the effective source of light outdoors on a cloudy day."

Indirect lighting in a commercial sense is usually considered to be the system of illumination in which the primary source of light is entirely concealed from view, and does not shed its rays directly upon the areas to be illuminated, such as the desk tops and drafting tables. Effective lighting comes from the comparatively broad expanse of the ceiling. Indirect lighting is frequently compared to diffused daylight because of its qualities of diffusion and the softness of shadows, and because of the ability of the eye under this type of illumination to function with ease and with minimum fatigue.

The principle underlying the diffuse quality of indirect illumination is illustrated graphically in Fig. 32, which shows the method by which the light is reflected and re-reflected from the ceiling and walls of the room. The light beam "A," for example, strikes the ceiling and is broken up into rays and reflected in a number of directions. Some of the reflected rays, as, for instance, "A-2,"

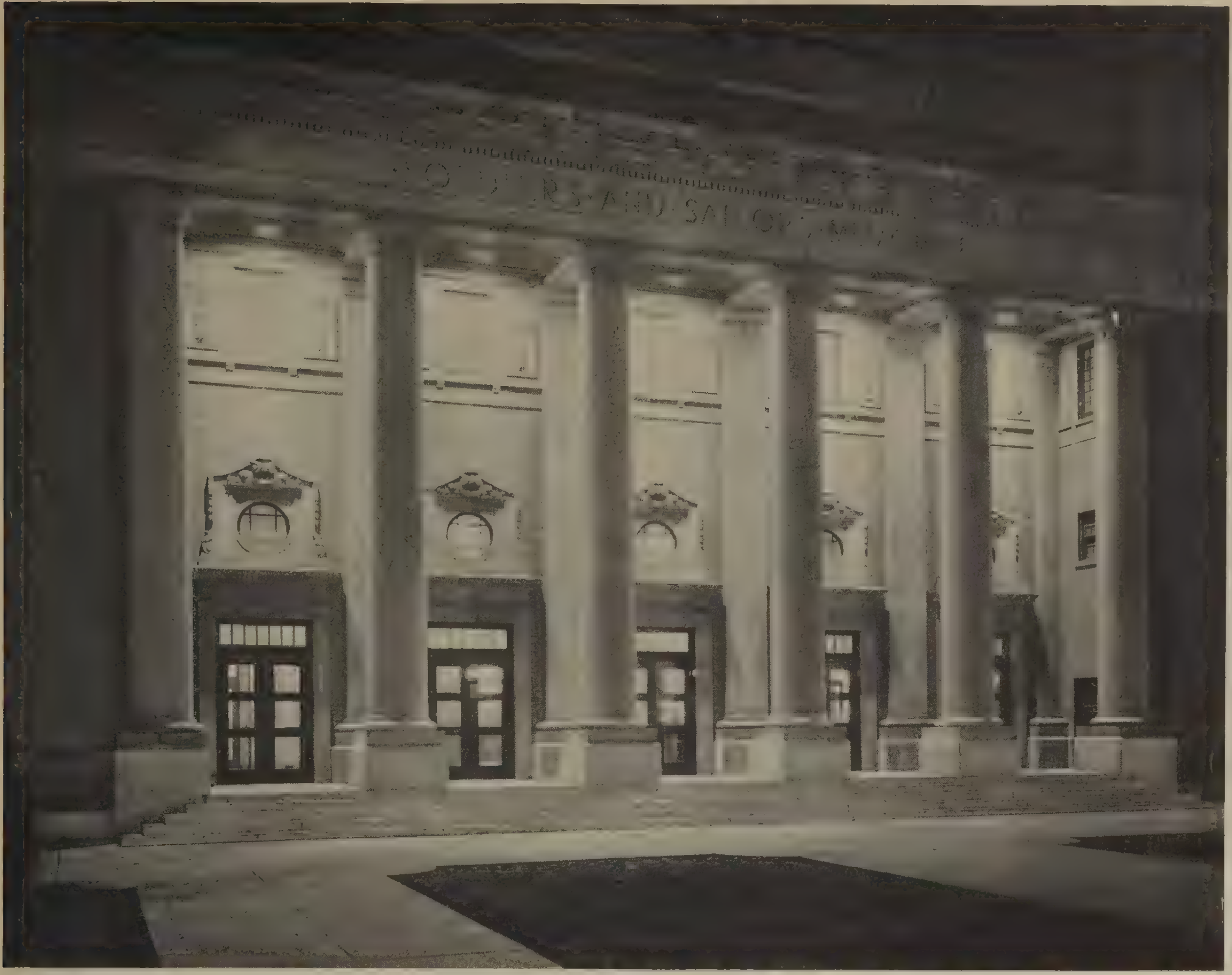


FIGURE 33—The portals of the Soldiers and Sailors Memorial Building in Kansas City, furnish an excellent example of light control. The architects were Rose & Peterson. Hidden reflectors bathe the entrance with dignified radiance.

go directly to the walls, where they are further broken up and reflected.

Thus it is that the illumination that reaches the desk tops is the combined effect of the multitude of reflected rays coming from many directions, each ray softening the shadows that might be cast by the others, and resulting in the diffuse daylight quality so characteristic of the indirect lighting system. Indirect lighting is not shadowless, as is sometimes supposed. The shadows are much softened, but not eliminated. Furthermore, indirect lighting has a directional effect, contrary to the popular notion, as can be easily demonstrated.

One of the first reasons for the desirability of the system of indirect lighting is the necessity for the shielding of the modern high powered light sources. The harsh candlepower of the lamp must be changed in distribution, in brilliancy, and sometimes in color, for our practical uses. We know that bright contrasts in lighting make seeing difficult. The seeing ability, or "vision acuity," is remarkably high for this system. The ability of the eye to distinguish detail is not wholly a matter of the intensity of the light in foot-candles, but depends upon the capacity of the eye to adapt itself to the lighting conditions. Sharp contrasts are avoided and glare is not present with any intensity of illumination by this system.

The first essential in the providing of equipment for indirect lighting is to select an effective light source. This is supplied in a very satisfactory manner by the gas-filled tungsten lamp in various sizes, ranging from 50 to 1500 watts. Of equal importance is the selection of the reflecting elements that are used in connection with the lamp. These should be of high quality, efficient, and constructed of such material as will make them capable of being fashioned or shaped to give the desired distribution of light, whether symmetrical or non-symmetrical. The most efficient indirect lighting equipments are those which employ the X-Ray silver mirrored reflectors designed especially for the purpose.

The amount of light delivered on the desk tops by the indirect lighting system will depend upon a number of conditions. As an average, however, about 30 per cent. of the light generated by the lamps reaches the desks and tables as useful illumination. In rooms where the decorations are kept in good condition by refinishing each year and by using light colors, the "efficiency of utilization" is much higher than the figure quoted.

The uniform value of illumination received in all parts of the room where this system is employed is suggested in Fig. 34. Curve "A" represents the values from a single indirect luminaire. It will be noted that the highest value of illumination is directly under the unit. The intensity in this case is represented by the vertical distance from the base line to a point on the curve.

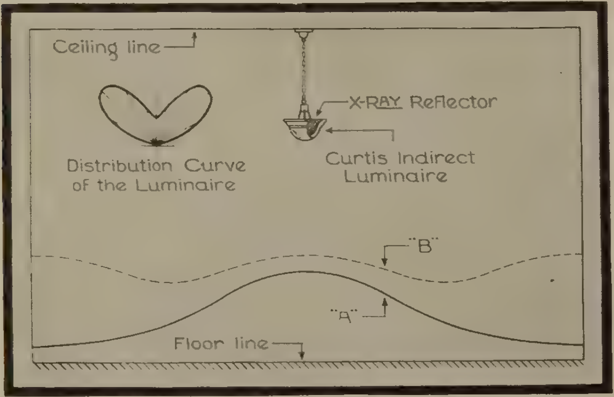

Ceiling line
X-RAY Reflector
Distribution Curve of the Luminaire
Curtis Indirect Luminaire
"B"
"A"
Floor line

FIGURE 34—The above curves show the uniformity or evenness of the lighting delivered by the indirect fixture. The intensity of illumination does not fall off rapidly one approaches the corners of the room. Curve A represents the lighting value from one unit, and Curve B is the result of two or three units when spaced 18 or 20 feet apart.

The curve "B," Fig. 34, represents the combined effect of two or three units, which, when the values are added, exhibits very uniform results. In large spaces where each location receives light from a number of units, the "uniformity curve" becomes essentially a straight line. The curve at the left illustrates the manner in which the light is distributed towards the ceiling by the standard type of indirect luminaire.

Indirect illumination has many and very definite qualities to recommend it. It is restful because of the lack of harshness. It is frequently described as "refined" because it lends a harmonious atmosphere of good taste. It is efficient when judged by the proper standards. It has been found to be productive because of its conscious heightening effect upon the working force.

The Luminous Bowl

All the indirect luminaires of Curtis Lighting, Inc., contain within the bowl of the fixture an X-Ray silvered glass reflector, designed for maximum efficiency in the control of light. Many of these types are illustrated on the pages that follow. Too often the popular conception of indirect lighting is that it consists of an opaque bowl or fixture suspended from the ceiling and containing a lamp and reflector, whereas this system is extremely flexible and lends itself to many and varied methods, as, for example, cove or cornice lighting, illumination from pedestals and standards, from wall brackets, column boxes, etc., etc., all of which are genuine indirect lighting and give the same diffuseness that is the outstanding characteristic of this most desirable method.

An interesting variation of the indirect lighting principle is to be found in the luminous bowl fixture, which also gives truly indirect lighting, and is not to be confused with the semi-indirect. Just as in the opaque indirect fixture of metal, glass or composition, each lamp of the luminous bowl unit is equipped with an X-Ray reflector for the proper directing of the light rays to the ceiling at correct angles to insure perfectly diffused illumination. Fig. 35 illustrates very clearly the principle of the luminous bowl, where a cut-away section drawing indicates the proper relation between the reflector, the glass bowl and the opal diffuser. When several lamps or reflectors are used in the bowl, a small lamp is provided for illuminating to a soft degree the outer glass bowl of the fixture, as in Fig. 36.

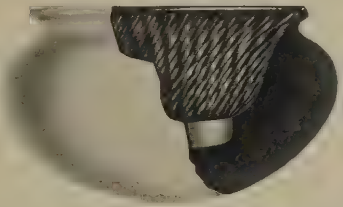


FIGURE 35—The luminous bowl X-Ray luminaire. Contained within the outer enclosing bowl is a silvered reflector and diffuser of white glass, permitting a small percentage of the light to pass through and softly illuminating the enveloping glass.

The luminous bowl method enables the brightness of the outer bowl to be entirely controlled. By increasing the size of the diffuser, or the small auxiliary lamp, the brightness of the bowl may be made greater. In any case, the brightness is not allowed to be so increased that there will be a strong contrast between the ceiling or walls and the bowl of the fixture, thus introducing the condition of glare that is so frequently found in many semi-indirect lighting installations.

That the lighting system in any interior may be efficient, and that the appearance of the room be pleasing, careful consideration should be given to the decorative finish of the ceiling and side walls. Although not directly a part of the lighting system, the walls, ceilings, posts and columns of the room constitute a secondary source of light, and much depends upon the reflective surface in obtaining a uniform distribution of light in the room. Newly painted white walls will reflect 70 to 80 per cent. of the light they receive, while yellow walls will reflect approximately 55 to 60 per cent. of the light. Dirty tan walls reflect from 25 to 40 per cent. of the light. These figures indicate the economic value of painting walls, ceilings and columns a light color. It should be borne in mind, however, that pure white wall surfaces may produce such a contrast that a glare may result. Where indirect lighting is used, the most pleasing and satisfactory ceiling finish is not white, but a color corresponding to that of the U. S. penny post card, which is slightly ivory in tone, and it will reflect about 80 per cent. of the light that falls upon it. Glossy surfaces should be avoided in the decorating of the walls and ceiling of the room. Side walls may be a slightly darker color than the ceiling, such as light buff or light gray, and still be very satisfactory from the standpoint of light absorption. Information concerning the reflection properties of various painted finishes is given in the table on page 312.

The color, density and surface finish not only affects the amount of illumination delivered in the room, but also its quality. Light penetrates further into some surface films than in others. If it is reflected from the dense surface of a highly glazed paint, it remains practically unchanged in color; but if the light penetrates somewhat into the surface it will be reflected back with a change of color, just as a ray of white light is changed when passing through a sheet of colored glass. When the color correction is not desired, much care must be used in selecting the kind of paint or finish used in the decorations.

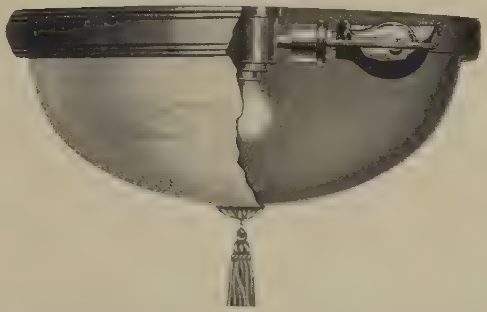


FIGURE 36—The multiple luminous fixture having several lamps with X-Ray reflectors. The lighting of the glass panels of the bowl to a pleasing brightness is provided by a small lamp as shown above.

One of the problems of primary importance that presents itself to the architect, or any one planning a lighting system for a building, is the question of the location of the electrical outlets. The wiring is so intimately associated with lighting that it is impossible to conceive a lighting installation without wiring. The difficulty with many of those in charge of the design of lighting installations in the past has been that they have not given proper thought to the wiring in the making of plans, hence many unsatisfactory conditions have been introduced into our buildings. Many of the structures do not permit of any flexibility in the arrangement of lighting a few years after their completion. In fact, some of the buildings are obsolete, so far as their wiring is concerned, the day they are occupied. Wiring has often been called the bottle-neck of lighting. It frequently occurs that an office or plant manager desires to provide better lighting conditions and is handicapped because the wiring capacities of the circuits will allow no additional load and not permit branches to the circuit being easily made. The vital need of providing adequate wiring is being given serious study by architects and electrigists, and proper standards are being established to provide for desirable minimums.

One of the difficulties in connection with the problem arises because the architect does not always have complete information and knowledge of the manner in which the building is to be divided and used, or what type of work is to be carried on in the various spaces. The layout should provide for such flexibility as to satisfy any conditions that may later be imposed upon it, and should permit minor changes to be easily made after the building is completed.

It is suggested that the wiring be so designed that no branch circuit of 1000 watts in rentable space should serve more than 400 square feet of floor area. Careful attention should be given also to the wire size used in the branch circuits, so that proper voltage will be maintained under all load conditions at the lamp sockets. The losses in effective lighting due to improper voltage are real and are clearly shown in the diagram on page 280.

It is to be regretted that frequently in making up the budgets for new buildings, the lighting is inadequately provided for. Experience has shown that, for the proper illumination of a building, from 1½ to 4 per cent. of the cost of the building should be set aside for the lighting. This does not include the wiring, but only the luminaires or lighting fixtures that are required. For example, for a building costing $25,000 three per cent. of this total cost would be $750, which is about the proper average amount to provide in the general budget for the covering of all of the electrical outlets of the building. In addition to this amount provision should be made for the cost of installation, of wiring, or any other accessories.

Hygienic Aspects of Good Lighting

Never yet has man, with all his cleverness and ingenuity, devised anything that even remotely approaches in delicacy of adjustment and adaptability the performance of the human eye and it is only of late years that illumination has been considered of vital importance in the hygiene of the eye. We are just beginning to understand how very essential it is that the eye be supplied with ample, diffused illumination to assist it in its important action, to help it perceive, to enable it to discern small details, to prevent the development of eye defects, and to conserve the vision, the most valuable of the senses.

The process of seeing is an extremely complicated one, a function that the eye is performing constantly during our waking hours, or whenever total darkness does not prevail, a function that is performed without our conscious effort when conditions for seeing are favorable. Without light vision would not be possible. Since vision is most necessary to us in our daily living, a proper understanding of the effect of light on clear and comfortable seeing is a duty that each of us owes to himself and to those in his charge. The manner in which light is used determines in a great measure how our eyes will function, the kind of service they are able to render.

The Structure of the Eye

The organ of vision, strictly speaking, consists only of the eyeball; but it has many important appendages: the eyelashes and eyelids, various secretory glands, conjunctiva or mucous membrane lining, and the lachrymal canal for drainage; all of which protect and aid the eye in its important function of seeing. The eyeball consists of three concentric coats and of certain fluid and solid parts. The tough, fibrous external coat is known as the sclerotic. The muscles of the eye are fastened to this firm structure except in front, which is transparent and is known as the cornea. The outer surface of this coating is pearly white, its inner surface of a light brown color. The middle or next inner coat is the choroid, a thin membrane that supports in its outer layers the large arteries and veins of the eye. Its inner stratum is covered with pigmented cells. in the front it folds back on itself and becomes thicker, forming the ciliary body. The colored iris is that part of the choroid which can be seen, and in its center is the opening called the pupil, the window of the eye through which light enters.

The innermost coat of the eye known as the retina, the delicate membrane containing the expanded termination of the optic nerve, forms the lining between the choroid and the vitreous humour extending nearly to the outer edge of the ciliary process. In this wonderful membrane no less than eight distinct strata build it up. The innermost layer is one of nerve fibers. Lying next to this is a layer of nerve cells. The outermost consists of pigment cells, and immediately within is the layer of rods and cones. These small bodies are closely packed together and are useful in conveying to the brain the impression of the images focused upon the retina. The aqueous humour is a watery liquid, while the vitreous humour is of a soft, gelatinous consistency, and serves as a support for the delicate retina.

The Seeing Process

In the process of seeing, rays of light from any object strike all over the surface of the cornea. This gathers them together slightly and a partial refraction follows in the aqueous humour; then the lens brings the rays to focus, in normal vision, on the retina. An impulse is transmitted by the optic nerve to the brain. All of the fine adjustments that are necessary in the seeing process are accomplished involuntarily. The convexity of the lens is brought about by the action of the ciliary muscles that hold the lens in place. The eyeball is rotated in every direction by six muscles. Coordination of these muscles control and harmonize the movements of the two eyes, resulting in a perfect alignment, which is one of the marvels of our vision.

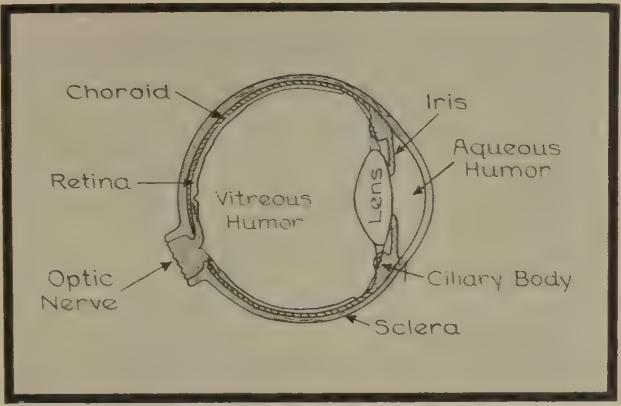
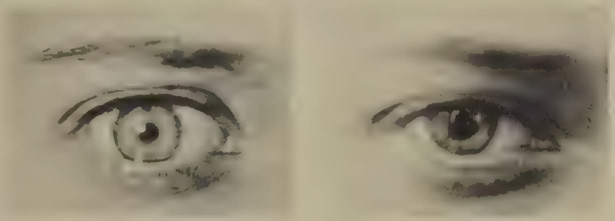


FIGURE 37—Above is shown general structure of the eye, and below at left the eye exposed to harsh glaring. unshaded light is subjected to tremendous strain. At right the eye functions normally, and in comfort under daylight and diffused indirect illumination.



For the mere physical act of seeing all we require is light. But proper vision consists of more than the mere perception of an object. It requires, in most cases, the discrimination of fine details.

Light is necessary to vision, as only when light enters the eye does seeing take place. We know light as a form of radiant energy, a wave length given off by substances usually at very high temperatures, traveling through space at the rate of 176,000 miles per second. Light waves are similar to the waves used in radio communication. They travel at the same rate of speed, but are different in length. The greatest of all light sources, of course, is the sun. We receive its illumination direct or by reflection from clouds and from the sky. We receive it frequently at night by indirect means from the moon and other planets, which do not in themselves generate light but reflect a small portion of the sun's rays to the earth. It is important to remember that for both natural lighting and for artificial lighting we see an object as a result of the light which travels, not from the source to the eye, but by the light that is reflected from the object itself. A bright light shining directly into the eye hinders vision rather than helps it.

Natural and artificial light are very much the same in composition. Both can be broken up into component parts or colors, although artificial light does not contain all of the colors and in the same proportion as in daylight. Regardless of the type of light that is furnished to the eye for its seeing, it must be capable of accommodating itself to the lighting situation. It is important, therefore, that the conditions for seeing be as ideal as possible to assist this important organ in performing its tasks.

Eye Defects

Many eyes are handicapped because they have inherent physical defects. Others are handicapped due to misuse or because they are subjected to wrong lighting conditions. Dr. George A. Dorsey, in his book, "Why We Behave Like Human Beings," states that there are thirty-four eye defects which are hereditary. Eight of these may produce blindness. Most of the common defects may be corrected by glasses, as, for example, myopia, or nearsightedness, due to the eyeball being too long. Its opposite, hyperopia, or farsightedness, is caused by the eyeball being too short. The defect known as astigmatism is occasioned by the fact that the front of the eyeball is curved more in one direction than in another.

Statistics covering many years show that nine out of every ten persons over 21 usually have imperfect sight. At 31 the proportion is larger. About 40 it is almost impossible to find a man or a woman with perfect vision. It was disclosed some years ago, by the examination of several thousand school children in one of our large cities, more than 60 per cent. of them had defective vision. Quite recently, the examination of more than ten thousand employees in factories and commercial houses, showed that 53 per cent. had uncorrected faulty vision, 13 per cent. had defects which were corrected, making a total of 66 per cent.

Diseases of the Eye

Our eyes are large factors in our efficiency. Nature allots each organ of the human machine a certain portion of nerve energy. When eyes that are defective demand more than their share of this nerve energy, it must, of necessity, lessen the normal supply. The wasting of nerve energy directly diminishes human efficiency. Often the victim of defective eyes is unaware of the fact that headaches, nervousness, drowsiness and irritability result from improper lighting conditions which may easily be corrected.

Because of the delicate structure of the eye, it is easily susceptible to injury and disease; and although much care may be used in correcting any physical defects, the eye will suffer if it does not work under favorable illumination. When the eye is abused defects in vision progress very rapidly, yet it is remarkable how quickly the eye will respond to treatment and how soon, under rational illumination, it will come back to its normal condition. Many of our eye troubles arise because of the necessity of using artificial light to such a great extent. We are all familiar with the well-known eye defects: conjunctivitis, trachoma, keratitis, iritis and glaucoma.

Recently, in our search for an expression to describe the defects of vision due to misuse of light, it was found necessary to resort to invention and devise a word which would properly and adequately convey the thought. The term *Optiphosis* was, therefore, suggested to express in one word the entire train of ills that befall the delicate human organ of vision resulting from the wrong use of lighting. This four-syllable word combines in its make-up the suggestion of the eye in "Opti," and a reference to light in "phos," both of which are of basic origin in our language. The word "Optiphosis" was introduced to the public on October 12, 1927, during a discussion of modern methods of lighting for office spaces at a convention of lighting specialists in Chicago.

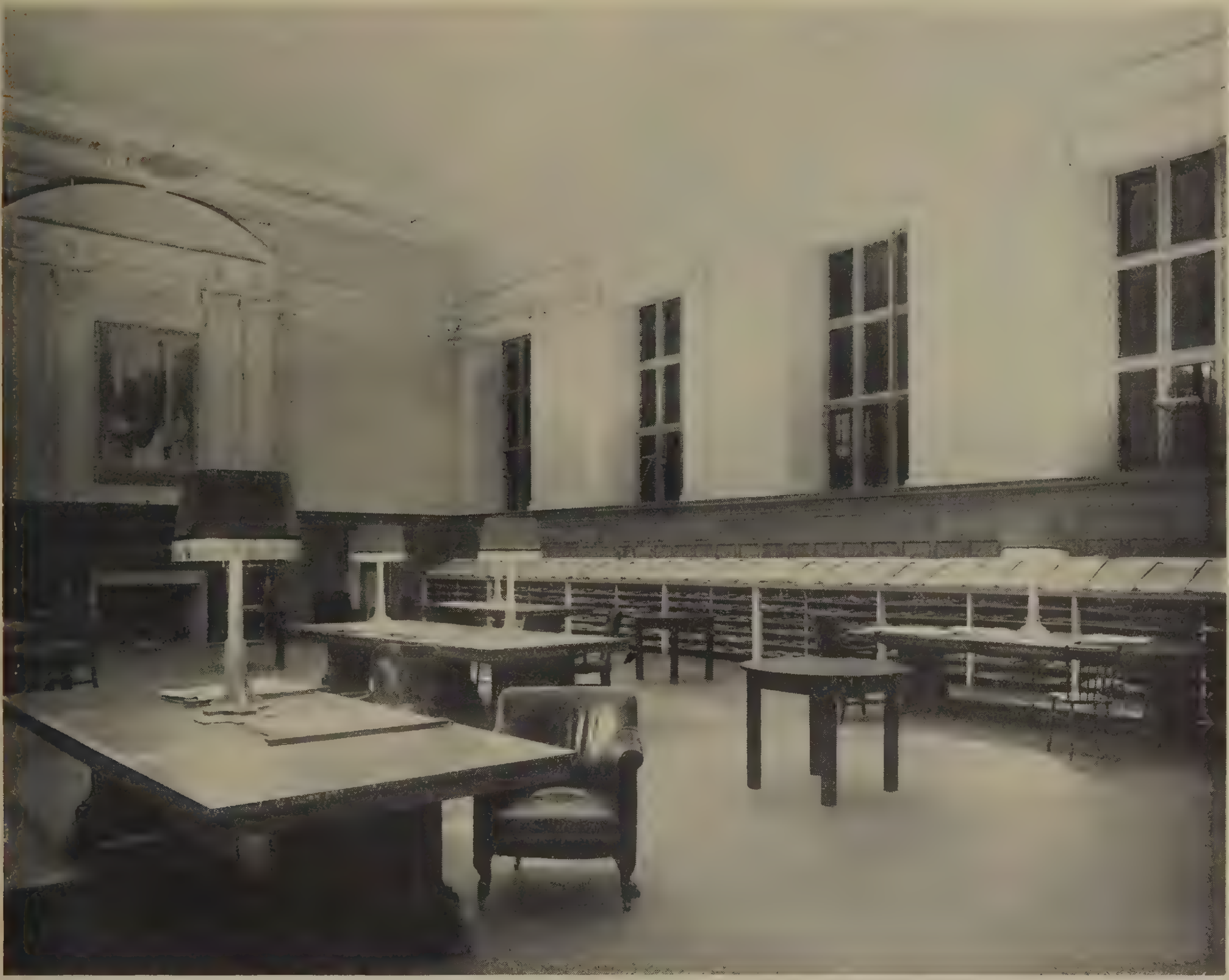


FIGURE 38—Reading comfort is an essential requirement in all libraries. The Curtis indirect portable lamp fully satisfies the need in the reading room of the Parliament Building at Ottawa, Canada.

Quality of Light

The quality of light supplied to the eye includes consideration of such factors as distribution or evenness of the lighting, the proper diffusion, the prevention of eye strain, the elimination of glare, proper shading and color.

Unevenness of the illumination is not only poor economy, but when the differences are large it introduces glaring contrasts and harmful brilliancies into the field of view. Unevenness of illumination on the reading page or working surface leads to fatigue of the eye by causing it to see its objects unequally well as it travels over the page. It tends to induce changes in adjustment to rectify the deficiency in the lighting.

The diffusion of the light is a very important contributory factor in relation to what is commonly called glare on the working surface. The other important factor is the way in which the surface reflects the light which falls upon it. It has been determined by scientists that diffuse reflection alone is serviceable to vision. The eye sees objects only by light that is diffusely reflected, not by the light that is specularly reflected, such as from polished and glazed surfaces. This light is directly harmful to vision. When the light is received directly from the source, concentrated, and perhaps wrongly directed, the effect is very detrimental to the hygiene of the eye.

In the discussion of this important subject we

FIGURE 39—Glaring lights are not only distressing to the comfort of the eyes of those occupying the room, but also destroy the character of the interior.

are taking the liberty of quoting frequently from the published articles of the eminent psychologists, Doctors Ferree and Rand, of Wilmer Institute, at Baltimore, Maryland. They have stated that, in an attempt to understand the effect of bad lighting on the eye, one of the most fundamental principles to keep in mind is that the eye is always under an incentive to clear up its vision. This incentive is very strong, so strong that it is extremely difficult to oppose it successfully by an act of will, or voluntarily to force the eye to make an adjustment detrimental to clear seeing. The eye has grown up under daylight. Artificial lighting, with its unnatural and unfavorable conditions for clear seeing, has come late in the history of the race, and the eye has not developed any reaction or adjustments to meet the conditions imposed. Yet the incentive to clear up seeing remains and leads to adjustments which frequently serve only to blur rather than to clear up the vision. This striving is the cause of what we commonly call "eye strain." This misdirected effort is of no service to vision and leads rapidly to fatigue and exhaustion. If the eye could only be educated to lie down under bad conditions of seeing, the cause of vision would be just as well served and the eye itself would be better off.

The most prevalent cause of eye strain from lighting may be summarized as follows: Low intensity lighting, which necessitates bringing the eye too near the work, and involves much effort and consequent rapid exhaustion; bending over the work, which causes fatigue and is likely to induce nearsightedness; the use of direct lighting not properly shaded; the rapidity with which the work is done in proportion to its delicacy and fineness; lack of constancy of the light source. Eye strain invariably results when more is required of the eye than should be reasonably demanded of it. The small, delicate muscles of the eye are certain to rebel if imposed upon. Even though the eye is normal and free from errors of refraction, improper lighting will produce eye strain.

Glare is unquestionably the most prevalent objectionable feature of improper lighting. It represents a positive waste of energy. Commenting on the subject of glare, the "Electrical World" published the following editorial:

"When one finds himself sitting in a draft in somebody's office or in a friend's house, he does not hesitate to protect himself from this exposure. He may change his seat, or may even ask that the draft be reduced or eliminated. This is a privilege

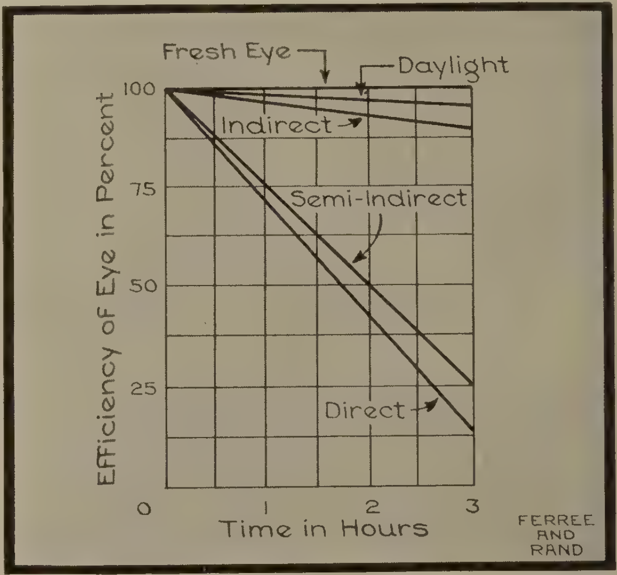


FIGURE 40—The loss of eye efficiency after three hours of visual work, as found by Ferree and Rand under various systems of lighting. Note that indirect illumination compares most favorably with daylight.

which is recognized by both host and visitor, and no offense is involved.

"Why should not the same principle be applied to lighting? How often one finds himself facing a glaring light source! Does he feel as free to mention this annoyance? Even those who recognize the harmful influence of glaring light seldom find it easy to suggest that it be shaded or extinguished. It is felt that the host might be offended, and, doubtless, there is ground for the fear.

"The effect of exposure to a draft is so easy to trace to its cause that every one recognizes the danger, and hosts would not suffer guests to be unnecessarily exposed. But the effect of exposure to glaring light sources is so indirectly associated with the cause that few persons recognize the evil.

"This illustrates very well the need for educational work in lighting, for a continual campaign against glare. The millenium in lighting will not have arrived until every one feels as free to complain against glare as against drafts. To bring this about is no small task, but constant, tactful, agitation whenever a proper opportunity presents itself will eventually change the attitude of the public mind."

There is only one proper way of judging a system of lighting, that is, by the way it helps us to see. We should not think because a light looks brilliant it is giving good illumination. It may be merely giving too much light in the wrong place.

A very comprehensive investigation of the effect of various lighting systems on the eye has been made by Doctors Ferree and Rand. The essential results of this investigation which have to do strictly with the loss of the efficiency of the eye after periods of work are given in Fig. 40. Without going into detail as to the methods of the test, the procedure was about as follows: A fresh eye was tested under the lighting system, then the observer was required to read for three hours seated in a definite position. After three hours of reading another test of the eye was made and the relative fatigue determined. This was repeated for each system of lighting.

The results show that with daylight the efficiency of the eye was about 95 per cent. after the three hour period, for indirect lighting about 90 per cent., while for semi-indirect lighting it fell to about 25 per cent., and for direct lighting to approximately 15 per cent. The test indicates that with the indirect lighting system the loss of the efficiency of the eye is practically negligible. Furthermore, it was demonstrated that with this system the results were practically independent of the observer as well as the intensities of illumination ordinarily employed.

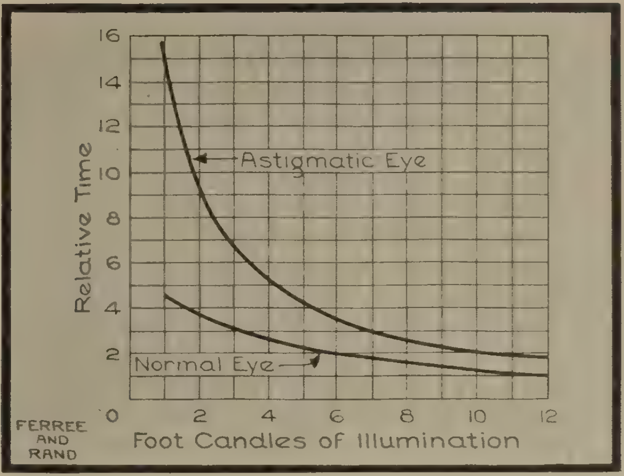


FIGURE 41—The relation between time and the amount of light required for vision. High intensities tend to compensate for the defect of astigmatism.

The color of the light supplied to the eye affects its power of seeing. Tests by scientists disclose the fact that the greatest speed and power to sustain clear seeing are given by the colors in the mid region of the spectrum. See Fig. 42.

Quantity of Light

In order that an object may be seen satisfactorily, a certain minimum amount of light must fall upon it. In other words, it must have adequate illumination. This effect of light upon the surface is spoken of as intensity or amount of illumination, and is measured in foot-candles. Recorded intensities of daylight range from several thousand foot-candles outdoors on a sunny day to a fraction of one foot-candle in an interior on a cloudy day. Recommended intensities for artificial illumination range from one foot-candle to fifty foot-candles, depending upon the use to be made of the light and the character of the room.

Under the intensity of daylight the eye sees much more quickly, sustains its power of seeing much better, is fatigued less quickly and suffers less discomfort than for the intensities of artificial lighting commonly used. This fact has an important bearing upon commercial and industrial lighting, especially where exacting performance is required of the eye. For such operations an increase in the intensity of light results in an increase in the ease and speed with which the employee does his work and a better power to sustain a high degree of performance throughout the working period, providing the light is properly diffused, distributed and shaded. If when the intensity of the illumination is increased there is also an increase in the number and brilliancy of bright sources of light in the field of view, producing glare, the attempt will result in harm and not good. The ratio between the time required to see and the amount of illumination in foot-candles is graphically shown in Fig. 41.

The effect of increase of intensity is greater when the work or details to be discriminated are small than when they are large, also when the difference in the coefficient of reflection between the object and the background is small than when it is large. The effect of increase of intensity is greater for light objects on a dark background than for dark objects on a light background. It is greater for an eye that is defective in refraction than for a normal eye. It is greater for the old than for the young eye. High intensities have a mentally stimulating effect. Every one is familiar with the somnolent effect of low and the wakeful influence of high illumination.

Conserving the Sight

It is apparent from the foregoing that the manner of using light is all-important. For our daily needs it is not sufficient to supply raw, uncontrolled light. It is necessary to diffuse the light, to deprive it of its dazzling sharpness and direct it toward the objects to be illuminated and to provide the daylight quality of indirect illumination whenever possible. Some common sense rules for the proper and efficient use of light are as follows:

Do not judge a lighting system by the brightness of the lamp. Because the lamp is bright and glaring is no indication that it is giving comfortable or adequate light.

It is bad practice to have an unshaded brilliant light glaring into the eye. This applies to all modern illuminants. A bright light in the field of vision means a very bright image on the retina, producing fatigue. Every one knows the blinding sensation of looking at the sun and the consequent dazzling, colored images. Bright and unshaded artificial lights do the same thing in a lesser degree.

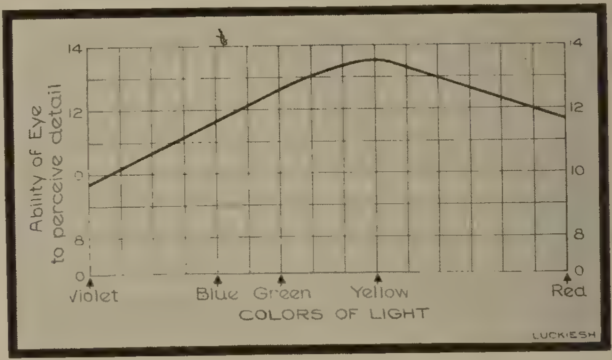


FIGURE 42—When colored light is used the eye can see best under a yellow-green color, as shown by the curve above.

Do not use a bright light against a dark background. Almost every light will glare unpleasantly if the surroundings are very dark.

Do not work by insufficient illumination. We should have enough light to make comfortable vision possible. Since we see things by the light which they reflect, it is evident that dark objects, which are poorly reflected, require more illumination than do light colored objects.

Finally, the most favorable condition of illumination for maintaining easy and comfortable vision through a period of time, compatible with other conditions of seeing, is to have the field of view uniformly illuminated with diffuse light, with no extremes of surface brilliancy. This condition is most efficient and satisfactory produced by the indirect lighting system using the X-Ray reflectors described in the previous section, and shown in practice on pages that follow.

Artistic Aspects in Lighting

It is by accents of light that we interpret the significance of the details of an artist's canvas. The same principle may be applied in giving proper emphasis to the meaning of the architecture and the decorative handling of our modern buildings. Just as the painter beautifies with skillful touch, we may now truly "paint" with tones of light, shade and color, with mediums that are even more flexible in their application than the artist's pigments.

We have for the materials of our art a most diverse assortment of lamps, color filters, reflectors and diffusing media. The absolute necessities of lighting have been supplied. The scientific development of lighting devices and the control of light have reached a stage which makes the present a most opportune time for the consideration of refinements in application and for the development of a decorative art in illumination.

Our approach of the lighting problem from the aesthetic standpoint is given a rather imposing character, and calls for the consideration of a number of very important features. For example, the effect of lighting upon the architectural treatment of any interior must be very carefully studied. Light properly applied will reveal and faithfully interpret the visions, in wood and stone, of our architectural geniuses. Light can assist in preserving the artistic appeal of the structure.

On the other hand, the type of architectural design selected by the builder has a marked influence upon the manner in which the interior is illuminated. Whether or not luminaires are employed, or "hidden" lighting is resorted to, depends upon the opportunity for the concealment.

Improper color harmony may entirely spoil a scheme of decoration that has been carefully studied and painstakingly applied. With color in lighting we have one of our most subtle tools for developing the refinements in this new art of illumination. Shadows are frequently used for this artistic effect, but if they occur where they should not be, due to ill-advised lighting arrangements, the result is very disturbing.

For each type of interior there is a characteristic and appropriate method of lighting treatment. What serves for an industrial plant is not suitably applied to a schoolroom, although we frequently find such inept practices. The intended character or dignity of a room may be preserved or destroyed by the simple act of switching on the light.

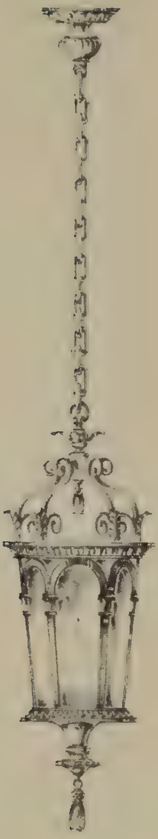
Symbolic features, frequently desired in churches and lodge halls, are influenced by the particular creed or order. Many interiors call for decorative touches, refinements which are independent entirely of the general illumination.

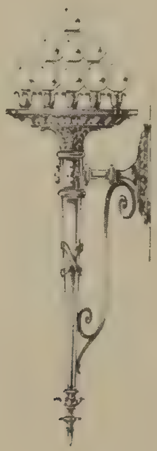
Lighting may be used to produce a definite atmosphere, because of its psychological effect upon the occupants of a room. The room may be apparently cooled or warmed by lighting effects alone.

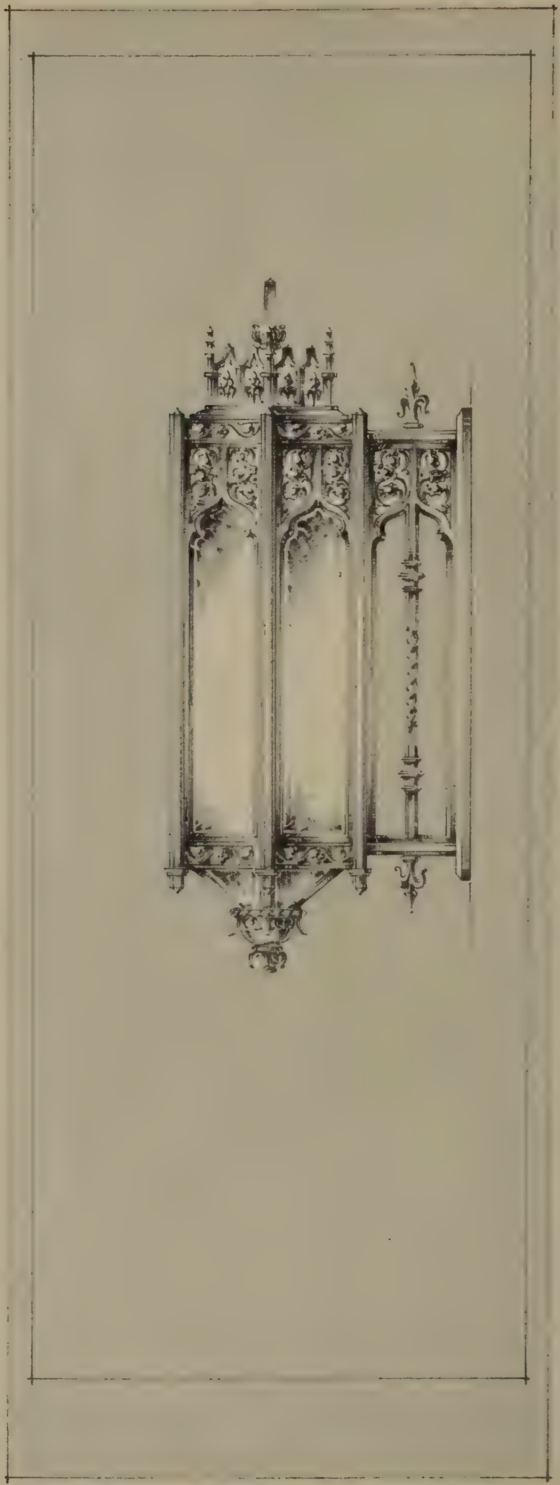
Harmony in the design of the luminaire is most important. Designs should be produced only in consultation with and under the guidance of a widely experienced artist, associated with an organization of craftsmen capable of interpreting in metal, glass or other physical substances the ideas of the designer, and executing them as faithfully as mechanical limitations will permit.

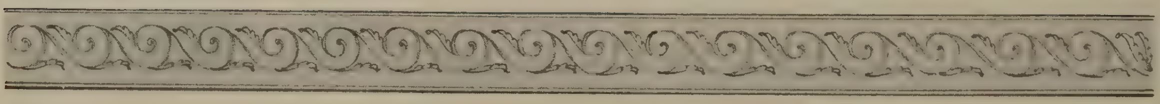
On the pages immediately following, and pages 118 and 119, a number of designs are pictured, showing characteristic luminaires produced and executed by Curtis Lighting, Inc., illustrating but a few of the infinite variety of pleasing forms developed by the Luminaire Studios. The scale, contour, detail and materials of each are the result of most careful consideration of all the elements entering into the making and use of the luminaire.

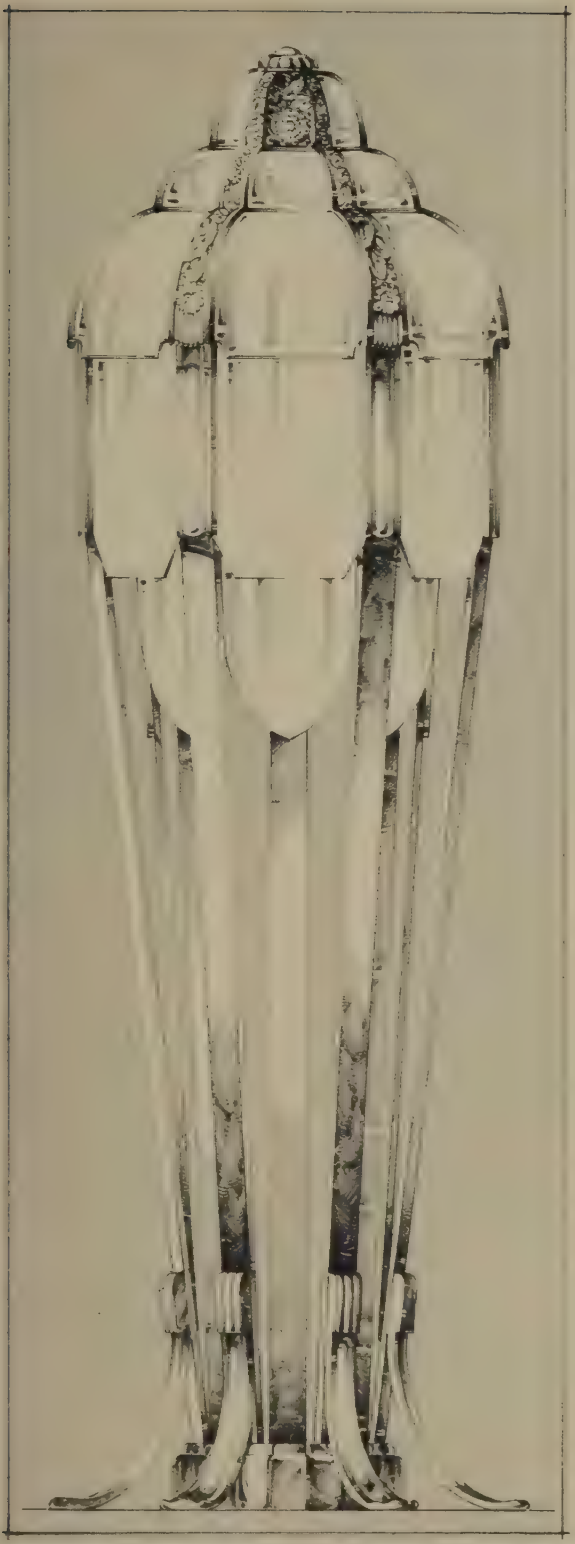
We know that, to conform physically, scale only need be considered, while for the aesthetic harmony environment, background, location and purpose are the factors influencing the design. Above all, the grouping of materials must be such that they will be satisfactory from the standpoint of artistic design and incorporate the principles of good lighting as regards eye comfort and the avoidance of over-brightness.

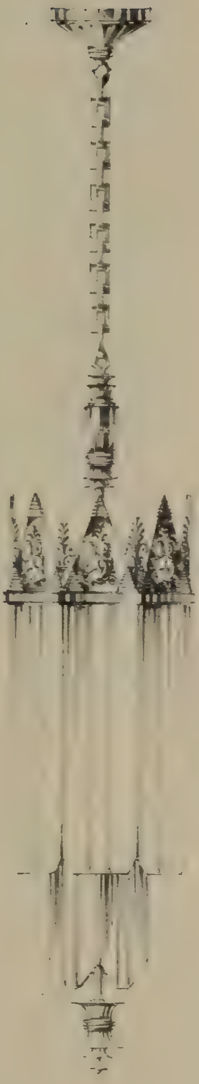


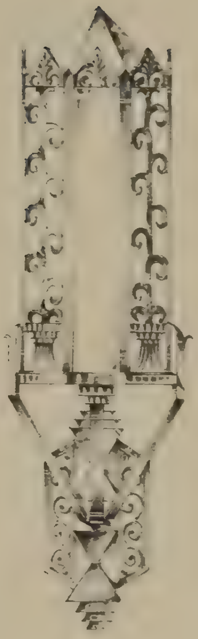




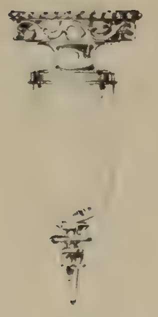


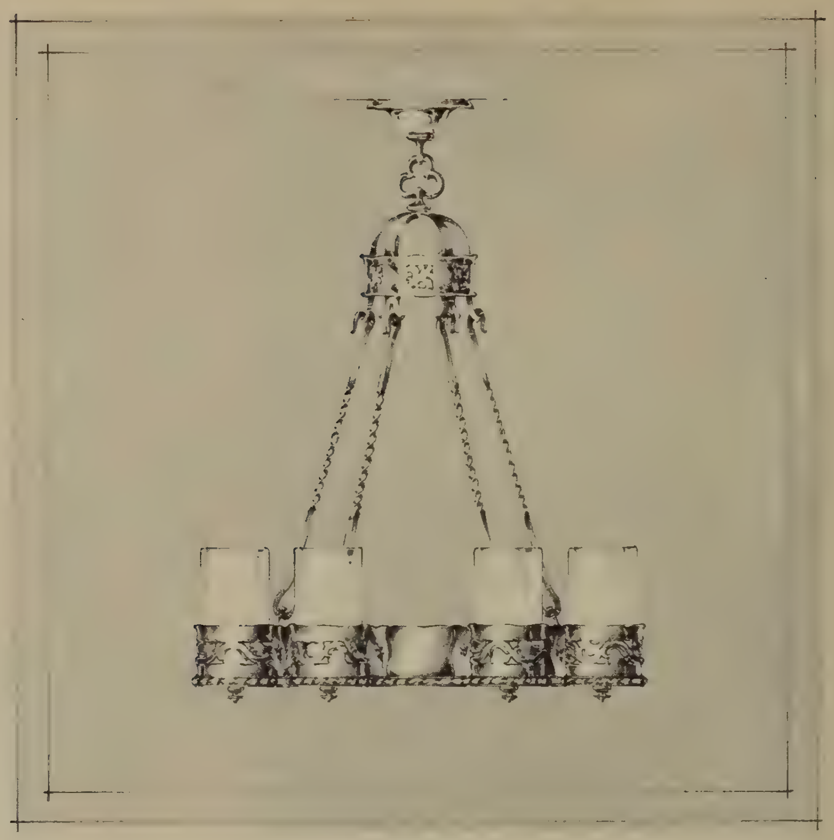


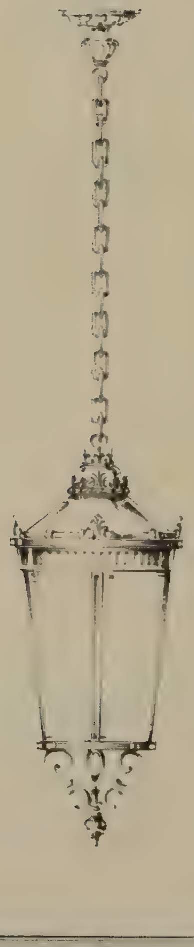


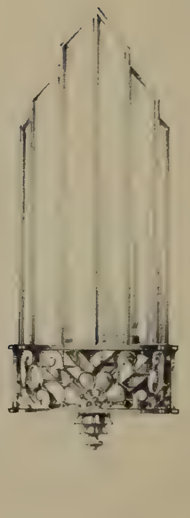


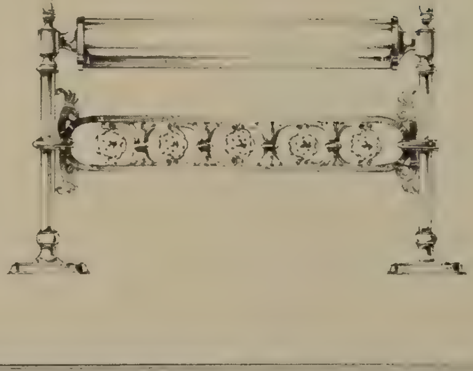
DESIGNED BY
LUMINAIRE STUDIOS
of
CURTIS LIGHTING
CHICAGO. ILL.

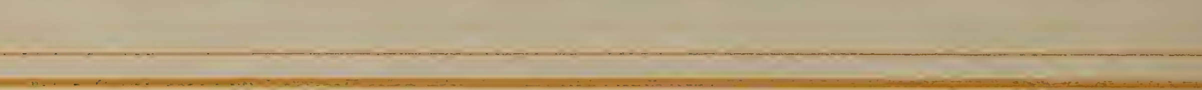


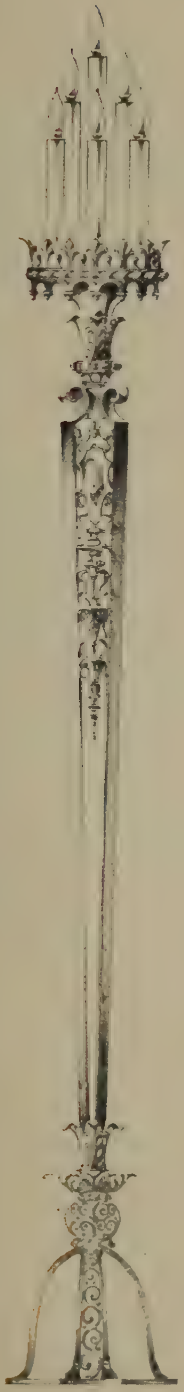


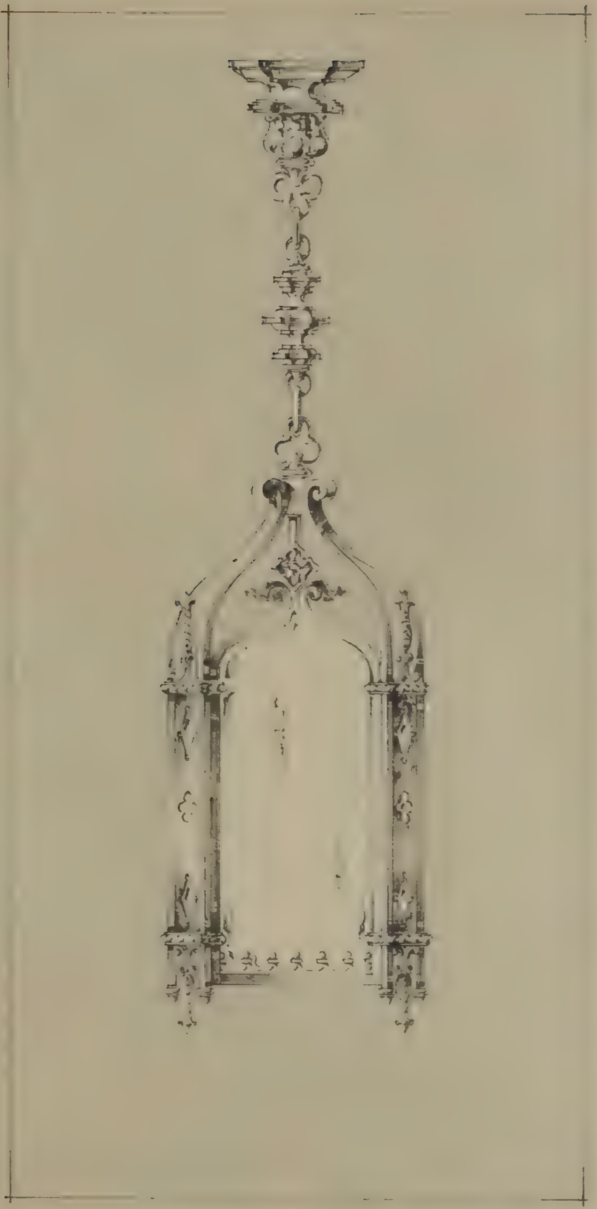


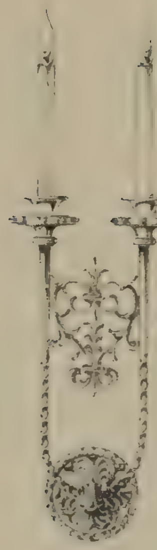


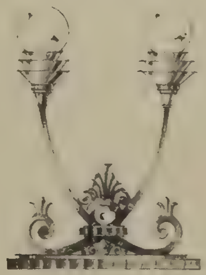












Designed By
Luminaire Studio
of
Curtis Lighting
Chicago, Ill.

Color in Lighting

From a standpoint of strict utility color could possibly be done away with, and from a like standpoint music has no large place in the world; but the person is rare indeed upon whom the flaming, gorgeous tints and colors of a sunset have no influence, and who would be just as well pleased with life if this garden of a world were inhabited by colorless birds, the fields deprived of their colorful verdure, or the hedges and gardens robbed of their infinite variety of tones.

Each of us has an "eye for color." The degree with which we perceive color and enjoy color contrasts differs widely with individuals. The normal man or woman can distinguish many shades of light and dark, as well as a large number of different hues. Everything that we see is colored. It seems, after all, that color is here to charm the eye. We cannot isolate ourselves from what has been called the "spell of color."

Sight is not the only one of the senses that is affected by color. All of the senses are directly or indirectly appealed to. The nature of the color governs the character of the sensations experienced by the individual. Each tint may have a marked influence upon the mental state and affects us pleasantly or otherwise.

It is the subtle colors that attract us most, not those of a pure or crude nature. Of course, the trained artist can discern and enjoy an unusual number of contrasts of colors, whereas most of us have a limited "emotional vocabulary" as respects color.

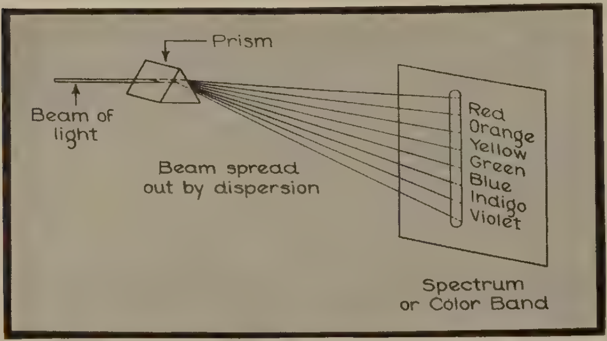


FIGURE 43—Sunlight contains all of the principal colors. This fact may be demonstrated by passing white light through a prism of glass, as shown above.

It is encouraging to note, however, that with each successive lighting season there is a broader use made of color concepts and a consequent enlarging of the sphere of color in the illumination of exteriors and interiors, resulting in a gradual development of color appreciation by the masses.

The general application of color in lighting has been hampered from time to time because of the mediums with which we have had to work. Colored fabrics, gelatin screens, dipped lamps and sheet glass have been fairly satisfactory in certain instances. However, in cases where the heat factor is large and comparatively great intensities are desired, the mediums mentioned will not wholly fulfill the requirements, because of fading and burning of the medium. Continuous service causes them to lose their character and efficiency. Dipped or colored lamps are useful where the heat factor is not an important element. They do not entirely meet the need however because of the expense of maintenance, replacements or lack of facility for dipping of lamps, mixing of colors, or carrying of sufficient stocks. With gelatin a great variety of colors is available, and when the sheets are placed in frames they are found to be very desirable for many classes of color lighting work, as, for example, the tinted illumination in show windows described on page 245.

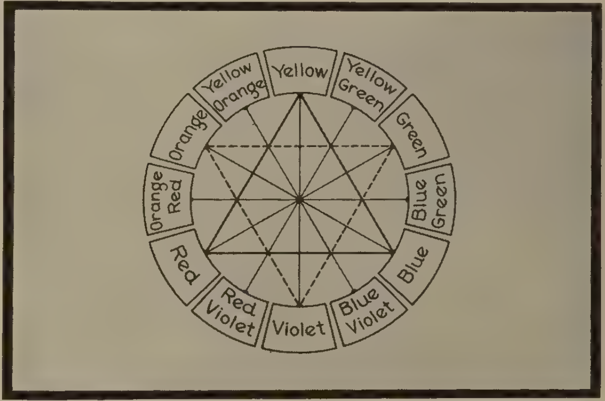


FIGURE 44—The color wheel, in which the colors of the spectrum are arranged in the form of a circle. The heavy triangle connects the primary colors, the dotted triangle the secondary colors. The colors at the ends of any diameter are complimentary colors.

With the advent of the gas filled lamp came large wattage units burning at high temperatures.

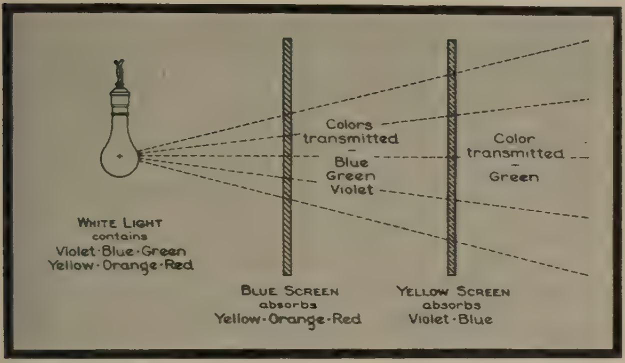

Colors transmitted
Blue
Green
Violet
Color transmitted
Green
WHITE LIGHT contains Violet·Blue·Green Yellow·Orange·Red
BLUE SCREEN absorbs Yellow·Orange·Red
YELLOW SCREEN absorbs Violet·Blue

FIGURE 45—The light from a natural or artificial source undergoes changes by absorption as it passes through screens or filters of glass or gelatin. The diagram illustrates subtractions by blue and yellow filters.

The heat generated further complicated the possibility of securing suitable color mediums for permanent installations. Because of lack of stability in color lighting effects and cost of replacements in the medium, a new type of special glass with the color incorporated in it has recently been standardized to solve this difficult problem for a large class of installations. These permanent heat resisting color plates are described and illustrated on page 285. The production of these special color plates is a very important improvement and will be of interest to those who are concerned with color lighting. By their proper application more satisfactory performance in this new color art is possible.

The work that has been done in the application of color in lighting, both for commercial and decorative purposes, has been met with such public approval that it has spurred on those interested in this development; so that the future evidently holds in store great surprises for all of us. The future will see startling results in the colored illumination of exteriors by means of floodlighting innovations, in window lighting, display rooms, exhibitions, in the lighting of interiors of churches, clubs, restaurants, public buildings of all kinds.

Much of the artistic value of lighting is still to be evolved. Our present task, therefore, is to help unlock for the future some of the world's color wonders, to that, as far as illumination is concerned, the generations to come may live in an atmosphere of refined color.

An unusual educational exhibit at the convention of the National Electric Light Association in 1926 was arranged by Curtis Lighting, Inc., to demonstrate the flexibility of modern lighting with X-Ray color mediums. "The Lady of Light," a life-sized wax model of a demure French miss was presented within a large shell finished in a silvery iridescence mounted on a beautifully decorated studio stage. The guests of the convention were permitted to "paint" the setting and the model of "The Lady of Light" with color lighting equipment manipulated from a complete dimmer switchboard at the entrance of the studio. The thousands of beautiful combinations possible with this equipment kindled a decided interest in the possibilities of color lighting for an increasing number of fields. The exhibit has been shown in many cities and in several countries of the globe, and has done much to stimulate color lighting everywhere.

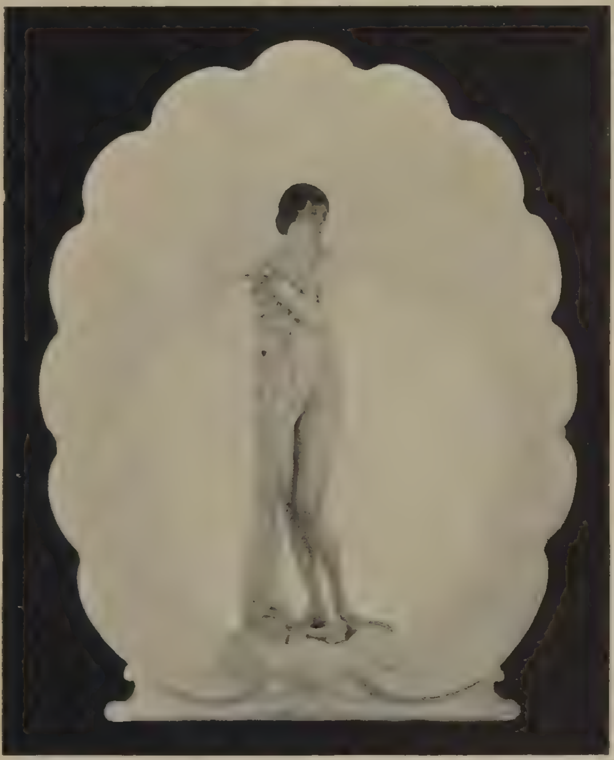


FIGURE 46—"The Lady of Light," an educational exhibit to demonstrate the unlimited possibilities in the use of colored illumination.

The Lumitone

A striking characteristic of our modern life is the growing use and appreciation of color. Our dress is the most colorful of any age; our homes are filled with furnishings in restful hues. Business establishments are using color lavishly in sales activities. The advertising sections of our modern magazines could easily be mistaken for the prospectus of an art exhibition. Color here, there and everywhere—and finally color in lighting. In fact, one of the most important and interesting phases in the trend of modern lighting is the extensive use of color, static or mobile, for the shop windows, for the theatre, dance hall, or for exterior lighting of buildings.

We know that to be most appealing color must be mobile and ever changing, blending from one tone or combination to another. The facility with which the blending is accomplished influences largely the pleasing character of the color picture. Many methods have been employed for the control of color circuits and blending of colors. The new and modern means of so doing, shown in Fig. 47, has recently been introduced in the form of "Lumitone," a device for the manual and automatic remote control of mobile color lighting.

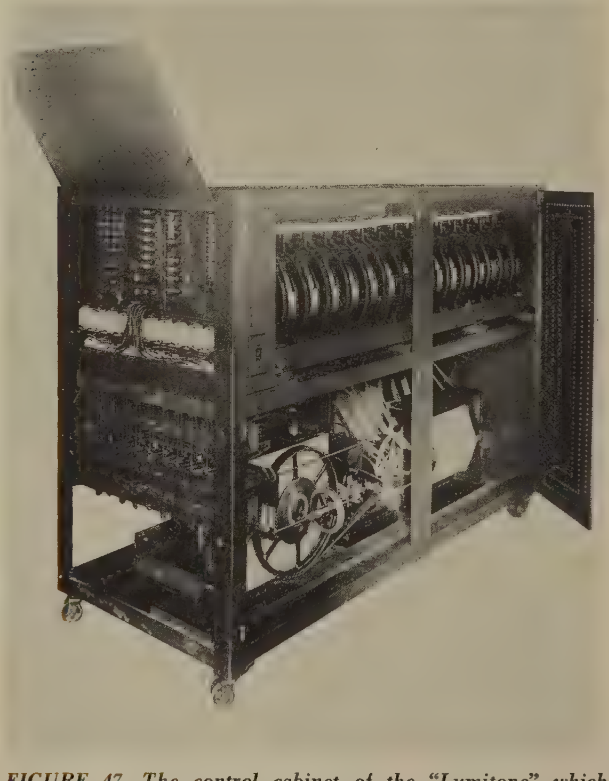


FIGURE 47—The control cabinet of the "Lumitone" which houses the driving motor, the automatic playing roll, dimmer mechanism and switching control.

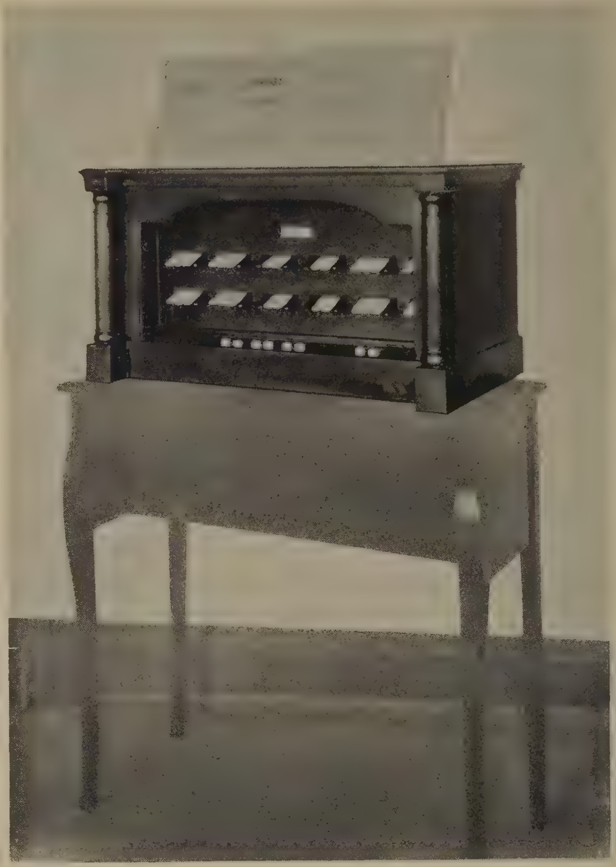


FIGURE 48—Typical console for the "Lumitone," showing the arrangement of control switch keys and buttons for special effects.

The dimming of the circuits is accomplished without flicker, and changes in color may be made exactly in a predetermined order. The fact that the control is based upon electro-pneumatics gives the opportunity for exact, quiet control, practically as subtle as that in the pipe organ.

As a perforated paper roll passes the openings in a tracker bar, the functions of turning on and off circuits and the operation of the dimmers are automatically performed. The nature of the color combinations may be predetermined and trancribed to the paper roll. The machine has great flexibility, inasmuch as all circuits are in no way related. The operation of the dimmer is inde-

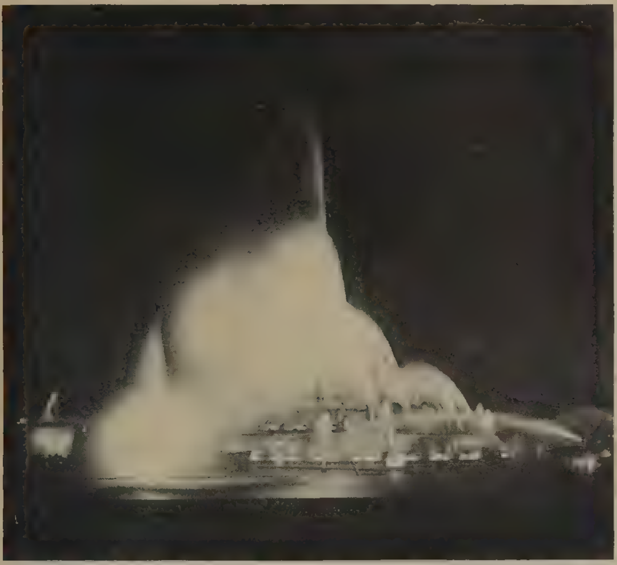


FIGURE 49—Special displays, such as the Buckingham Fountain in Chicago, lend themselves admirably to the use of "Lumitone" control.

pendent of the electrical circuits, enabling any combination to be "preset." Further flexibility is obtained by various speed controls, and manual operation by means of a console keyboard.

The construction of the console is indicated in Fig. 48, and is built in such a manner that keys for each individual circuit are grouped and are of distinctive colors, thus easily identifying the nature of the circuit that one might desire to operate. The manual of the console keyboard is divided into three main sections, solo, accompaniment and special effects. The solo section plays all the colors of the equipment which are directed towards the main feature of the display. The solo keys are placed in the upper bank, similar to a pipe organ, and are customarily played by the right hand. The accompaniment section plays all the colors on the background, which may be kept subdued as in a great solo, or may be brought up in a crashing crescendo as in a large chorus effect. The accompaniment keys are placed on the lower bank, and are usually played with the left hand. The special effect controls are placed in the shelf of the keyboard, and are used when something out of the ordinary is to be executed.

One special effect key, known as the "crescendo," brings all the lights up at once, and is used for a finale or other effect which demands that the amount of light be increased as quickly as possible. Another key, which is the reverse, and indicated as a "diminuendo," dims all the lights at once and is extremely useful in subduing when the entire display is too bright. Other keys control the machinery which operates the automatic mechanism. Still others may be used for slowing down the rate of change of the lighting intensity, thus affecting all of the dimmer circuits. If the rate of change is to be increased for all the circuits, a key known as "tempo fast" is engaged, while "tempo slow" produces the reverse effect. A special key turns out every light on the display. They may again, as easily, be restored without changing in any way the dimmer positions or the general nature of the lighting arrangement.

Each color group consists of four keys, one of which is the color of the circuit and turns on the light, the two center keys of the group operate the dimmer, one running the dimmer up and the other down. The fourth key, black in color, turns off the switch controlling the electrical circuit.

The manual operation with the console keyboard is installed only where this type of operation is desired. In the usual installation of the Lumitone only the automatic control cabinet is supplied. The smallest machine handles but one circuit of each color. Specially designed machines may be made to control any number of circuits

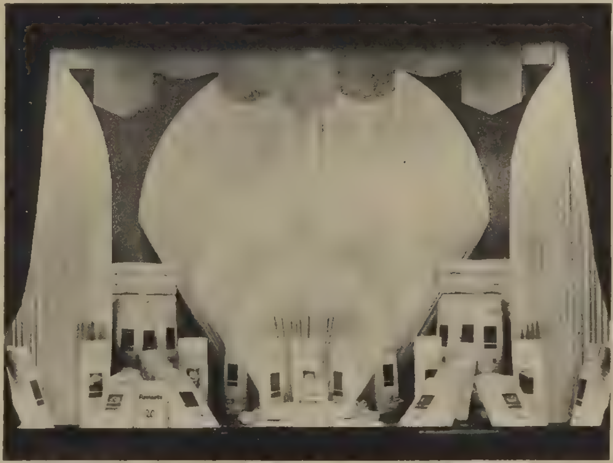


FIGURE 50—A show window display in the store of T. Eaton Company, Toronto. A type particularly adapted for color display with the "Lumitone."

of any wattage. The entire mechanism is operated without flicker, changes being so gradual that they are scarcely noticeable. The fast graduations of speed and movement are accomplished by the unique control. As the dimmer actuating mechanism is independent of the electrical circuits, the possibility of short circuits is entirely eliminated.

In making installations of the Lumitone the control cabinet may be placed in any convenient position, not necessarily close to the object to be illuminated, since the connections between the setting and the control cabinet are electrical.

There is an endless fascination in "playing" with colored light. Many pleasing combinations are obtained. Very few discords occur in the blending of colors. As a suggestion as to where the Lumitone might be employed in the control of colored lighting, the show window display is first mentioned. The public judges the character of a store largely from the window display. Anything of unusual attractiveness to the passerby calls attention to the establishment of the goods displayed, and a very important impression is made upon the prospective customer. In making application of the Lumitone to window displays the existing lighting equipment may be employed. It is a very simple matter to utilize the present circuits. Other uses for this device will be found in public lobbies' interiors in which cove lighting is installed, auditoriums, ballrooms, dance halls, cabarets—in fact, any installation in which movement of colored lighting is desirable. Unusual lighting effects may be produced on fountains, waterfalls or for the floodlighting of buildings to reveal the beauty of architectural composition, with this new and interesting device.

PART FOUR

MODERN LIGHTING PRACTICE

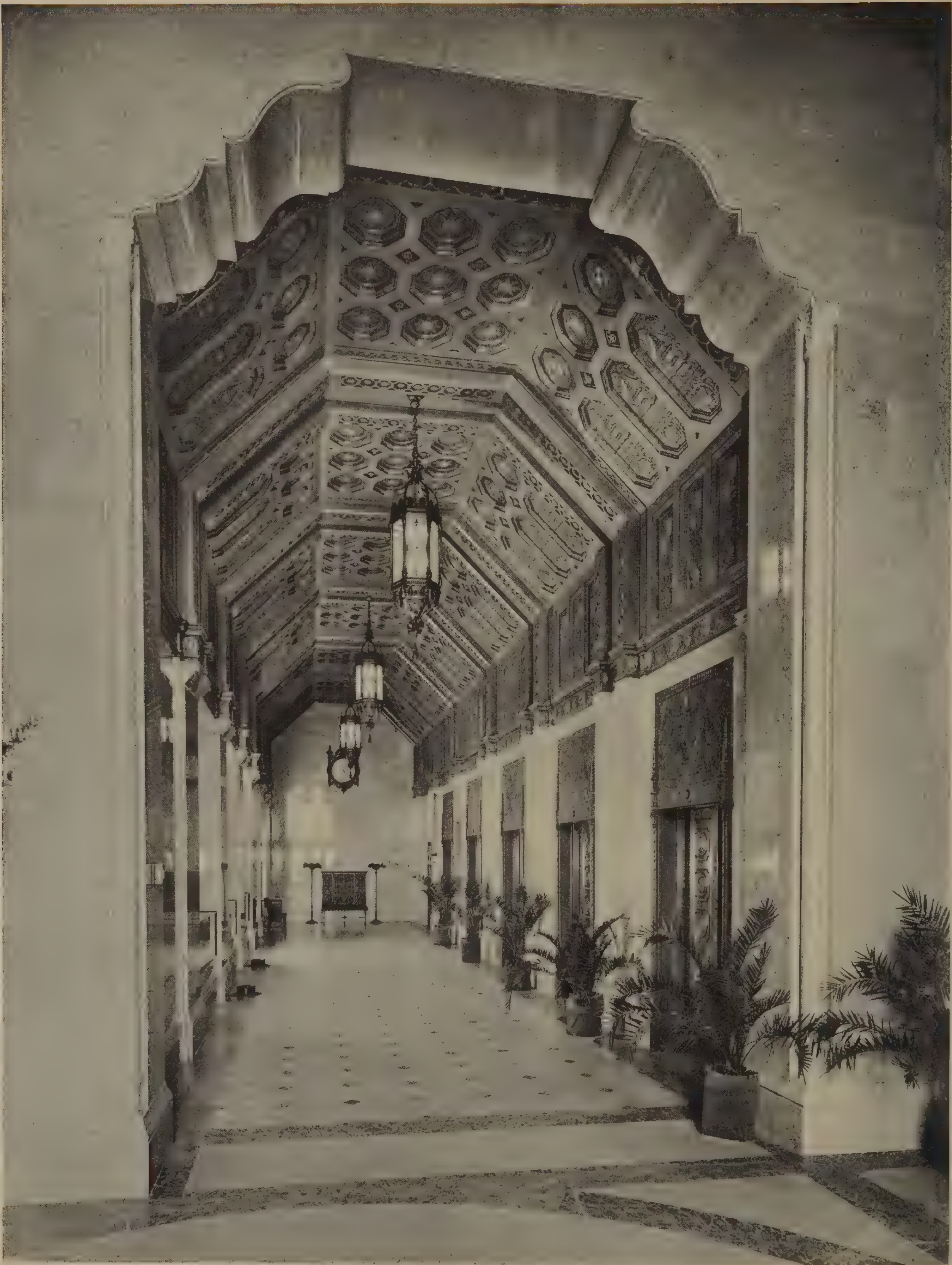
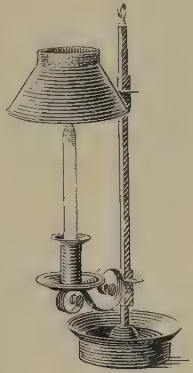


FIGURE 51—Public lobby of the Administration Building for the Southwestern Bell Telephone Company, Dallas, Texas. Lang & Witchell, Architects. Decorative art bronze luminaires combine the utmost in adequate and comfortable lighting.

PART FOUR ·· MODERN LIGHTING PRACTICE



SUGGESTIONS of the great variety of uses to which modern lighting may be put were incorporated in the address of President Hoover at the celebration of the fiftieth anniversary of the invention of the incandescent lamp by Thomas A. Edison. The remarks made by the President on the evening of October 21, 1929, at Dearborn, Mich., were in part as follows:

"The multiplication of the amount of light in the world a thousandfold is worthy of celebration, for darkness is a forbidden limitation upon righteous human activities.

"When Mr. Edison invented the electric lamp he may, perhaps, have thought just to produce plain light and more of it at less cost. I surmise that his wildest ambition was to relieve the human race from the curse of always cleaning oil lamps, scrubbing up candle drips, and everlastingly carrying one or the other of them about. He may have thought to add safety to Chicago against a second accident from an oil lamp.

"But the electric lamp has found infinite variety of unexpected uses. It enables us to postpone our spectacles for a few years longer; it has made reading in bed infinitely more comfortable; by merely pushing a button we have introduced the element of surprise in dealing with burglars; the goblins that lived in dark corners and under the bed have now been driven to the outdoors; evil deeds which inhabit the dark have been driven back into the farthest retreats of the night; it enables the doctor to peer into the recesses of our insides; it substitutes for the hot water bottle in aches and pains; it enables our cities and towns to clothe themselves in gaiety by night, no matter how sad their appearance may be by day. And by all its multiple uses it has lengthened the hours of our active lives, decreased our fears, replaced the dark with good cheer, increased our safety, decreased our toil, and enabled us to read the type in the telephone book. It has become the friend of man and child."

Progress in lighting methods and applications has been extremely rapid in the last few years. A system of illumination considered as satisfactory from the standpoint of amount and quality, installed ten years ago, does not measure up to our present day standards. Owners and executives are beginning to realize this fact, and are seeking accurate information, not only on how to properly install lighting, but desire to know something about its economic value. The lighting industry has responded by carefully studying the requirements for lighting, and is ready to advise on these important subjects as well as to supply equipment that has by extensive experience and practical test been found to produce the desired results.

Cooperating with the Architect

Much of the success that has been obtained in modern lighting practice is due to the close cooperation of the architect, lighting specialist and others involved in the construction and equipping of buildings. The specific examples that are to be found on the pages that follow illustrate the results of a mutual understanding, which has resulted in the satisfactory solution of many difficult problems. Those who devote their energies in future to the rapidly developing business of decorative lighting will find an increasing necessity for close working of all who have a part in developing the plan.

The proper arrangement and capacity of electrical circuits, convenient placing of outlets, providing of adequate spaces in cornices and moldings for the concealment of lighting equipment, as well as many other minor architectural details that influence the lighting scheme, the saving to owners of subsequent great expense for alterations, the avoiding of placing glaring units casting disagreeable shadows, or the subjecting of occupants of the interior to discomfort and unnecessary glare, etc., etc., all are the logical results of this cooperation.

The mutual responsibility begins early in the conception of the building, and if we do not recognize it, inharmonious or even disastrous results may occur. Years of experience have shown that the old method of leaving for the last the consideration of the lighting features is most unsatisfactory. Although the lighting man can logically take the initiative in suggesting changes in old practices, it is the architect who must finally accept and incorporate in the building the new ideas if they be in harmony with the many other elements of the structure.

In our cooperative effort with the architect we, therefore, encounter examples of three kinds: those requiring no particular compromise in lighting or in architectural arrangements; those requiring architectural modifications to accomodate lighting facilities; those in which departures from standard lighting methods must be made to conform to architectural or structural necessities. It often occurs, in attempting to satisfy the exacting conditions imposed in examples of the latter two types, that the results are somewhat imperfect when judged either from the standpoint of good architecture or from the standpoint of good present day lighting practice.

From the viewpoint of the architect, modern lighting can serve two purposes. First, that of insuring proper illumination effects for the building; and, second, that of accentuating his work, revealing it, whether it be an interior or exterior, to an appreciative public, and resulting in a satisfactory something to the architect that may be called "advertising value." Of all the elements that go into its making, without doubt the most potent factor in controlling the atmosphere and spirit of an interior is the lighting, providing it is properly planned as a component part of the architectural design of the building.

In discussing the question of definite lighting aims, the "Electrical World" recently stated in its columns, that perhaps the most critical task in arranging the illumination of a public building is

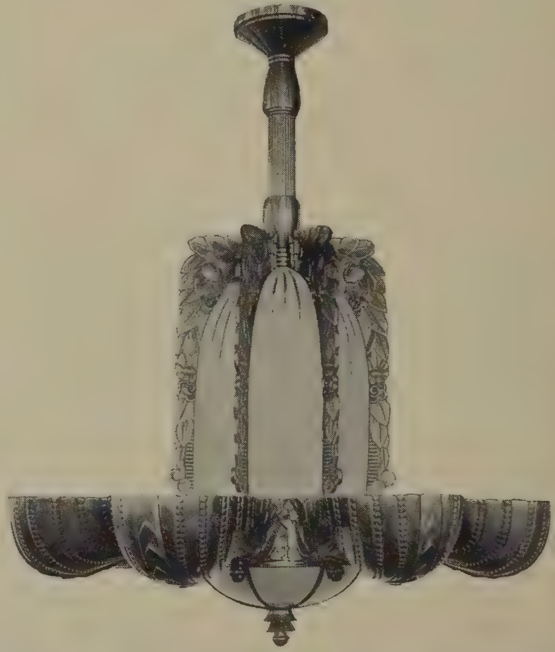


FIGURE 52—A modern luminaire, which not only follows the present day mode in design, but which also incorporates indirect and direct lighting features with X-Ray reflectors.

to adjust the character of the lighting and the luminaires to the general architectural requirements. In this matter more than anywhere else has illumination suffered from bad precedent, since in very many instances the lighting of a building in the past has borne no relation whatever to the architectural harmony of the whole. Lighting fixtures have been regarded too often as things to be judged alone and not in company with their surroundings. Hence it has happened many times that fixtures beautiful in themselves, considered merely as objects of art, have been put in very inappropriate situations; or, on the other hand, fixtures possessing no particular merit have been thrust into service from merely utilitarian motives. From long custom and a slavish regard to ancient precedent, however bad, people have come to tolerate inharmonious treatment of lighting fixtures. For example, the exaggerated pendant lights of the mosque of St. Sophia, decorative enough individually but hanging from absurdly long and conspicuous rods, have served as a motive for an infinite amount of bad church lighting.

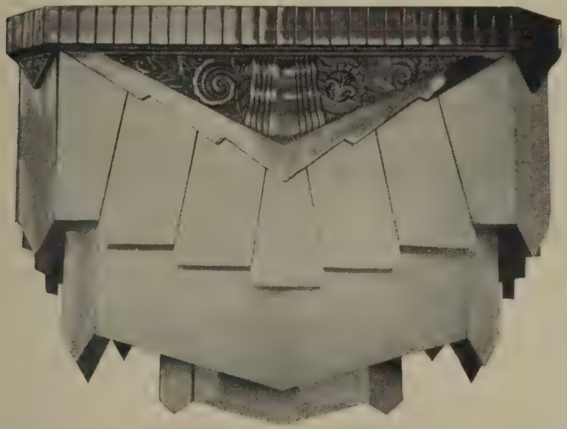


FIGURE 53—Another example of the work of the Luminaire Studios of Curtis Lighting, Inc. A modern piece designed expressly for the Masonic Temple in Rochester, New York. Osgood & Osgood, Architects, Grand Rapids, Mich.

Many of our so-called decorative lighting fixtures are merely those of the days of candles, electric lamps having been substituted for the flame-light sources. Obviously such fixtures are considered only from the art side, for it is evident that none of the modern possibilities of light control has been introduced into their design. Modern artificial light is controllable beyond any comparison with the light from flames. This is one of our wonderful heritages from scientific development in the past few decades.

Moderne Lighting Interpretation

We are gradually learning to adapt modern means to modern needs, and in practically every aspect of our present day life we see manifestations of impatience with traditional things. Ours is the age of transition, of revolution, of emancipation. A lack of restraint, a sense of freedom, and an urge to experiment have brought about the skyscraper in architecture, fabrics of vegetable silk, impressionism in art, the radio in communication, the "Piggly-Wiggly" in merchandising, and a numerous train of other innovations as products of our mental tendencies.

It is not surprising that this mental attitude is having its effect upon our arts and sciences, inasmuch as the arts in any age tend to portray the life of that age. Contemporary art is an expression of contemporary life. Thoughtful men do not abandon the smooth and easy practice of working along established lines until it means a giving up of individual freedom and a restricting of the expression of their impulses.

We are striving for something new; we no longer accept what was considered the "last word" of other years, and so there has been evolved what is known as "modern art" to interpret our modes and manners of today. We find new beauty in the angles, contrasts and coloring that characterize this vogue, the influence of which has entered into practically every phase of design because of its adaptability.

European history provides us with an interesting picture of changes—from the classical to the medieval, then from the medieval to the Renaissance. And today we are passing through a new and important change. The art in industry must necessarily change, just as manufacturing processes and methods of construction must change if progress continues to be made. In the planning of new buildings we have reached a point where the architect is groping for new modes of expression, types in which lighting plays a more important part than ever before.

We have all appreciated for some years that there is more to lighting practice than its mere technical demands. Never before has the architect been so thoroughly impressed by the value of electric light as a decorative medium. Therefore, much of the inspiration for the new lighting methods is coming from the architectural side.

In the world of building and in the application of lighting the near future will produce examples that are unique and refreshing. In years gone by lighting was too frequently considered as something to be added to the structure after its completion, but in the new conception it will be built into the fabric of the building.

Many would strive to preserve the traditional and predict that the old ideas will come back. In our applications of lighting who would have thought of going back fifty years, for example, to the use of the petroleum lamp and the candle with the flickering flame and feeble glow produced by these illuminants? They correctly expressed their age—an age of unsteadiness and wavering in the development of our country.

We are confronted with new opportunities of expression in illumination methods. We are also face to face with great obstacles. With the advantages of the new mode will come limitations. We must preserve our ideas and ideals concerning the fundamentals of good illumination. The greatest danger is in the tendency on the part of mediocre designers to introduce factors of glare. Eye comfort with illumination from concealed sources is more essential today than ever before, because of the increasing brilliancies of the lamps used in everyday practice. If we are not watchful and do not plan along rational lines, we shall find ourselves coming into an age of glare, even more insidious than anything that has been experienced in the past decades, when bare lamps were improperly shaded with inferior glassware.

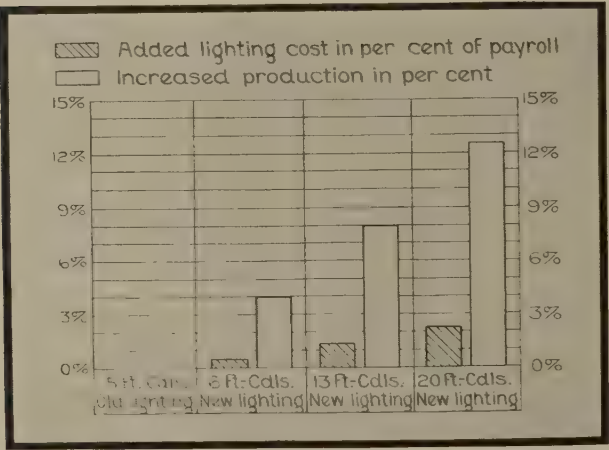


FIGURE 54—One of the economic results of good lighting. Production in industrial plants increases very rapidly at small added costs for improved illumination.

The brightness of some of the bracket fittings and other units that are now being installed in our public interiors is much beyond what we consider to be safe from the standpoint of eye comfort. The good designer knows that modern luminaires are more than mere jagged pieces of glass set together in a more or less haphazard manner. Modern lighting may be done in perfect harmony with tendencies in design and decoration, but yet incorporate the idea of proper illumination as regards utility and eye-comfort.

It is difficult to trace the new origin of this new movement in lighting. We know that it was given a very stimulating forward move in 1925 at the Arts Exposition in Paris, although one of the most important and revolutionary tendencies in modern lighting can be dated from the introduction of commercial indirect lighting about twenty years ago by Curtis Lighting, Incorporated. The fact that this system has become a standardized method for interior illumination indicates that concealment of the lighting source and diffusion from broad surfaces such as the ceiling is fundamentally correct. Extensive applications of cove lighting and similar forms have since been made, utilizing architectural elements for the concealment of the lighting sources. The modern movement in light has, therefore, been on its way ever since the illuminating engineer has been attempting to control the radiance from artificial sources to obtain greater lighting utilization and greater seeing comfort.

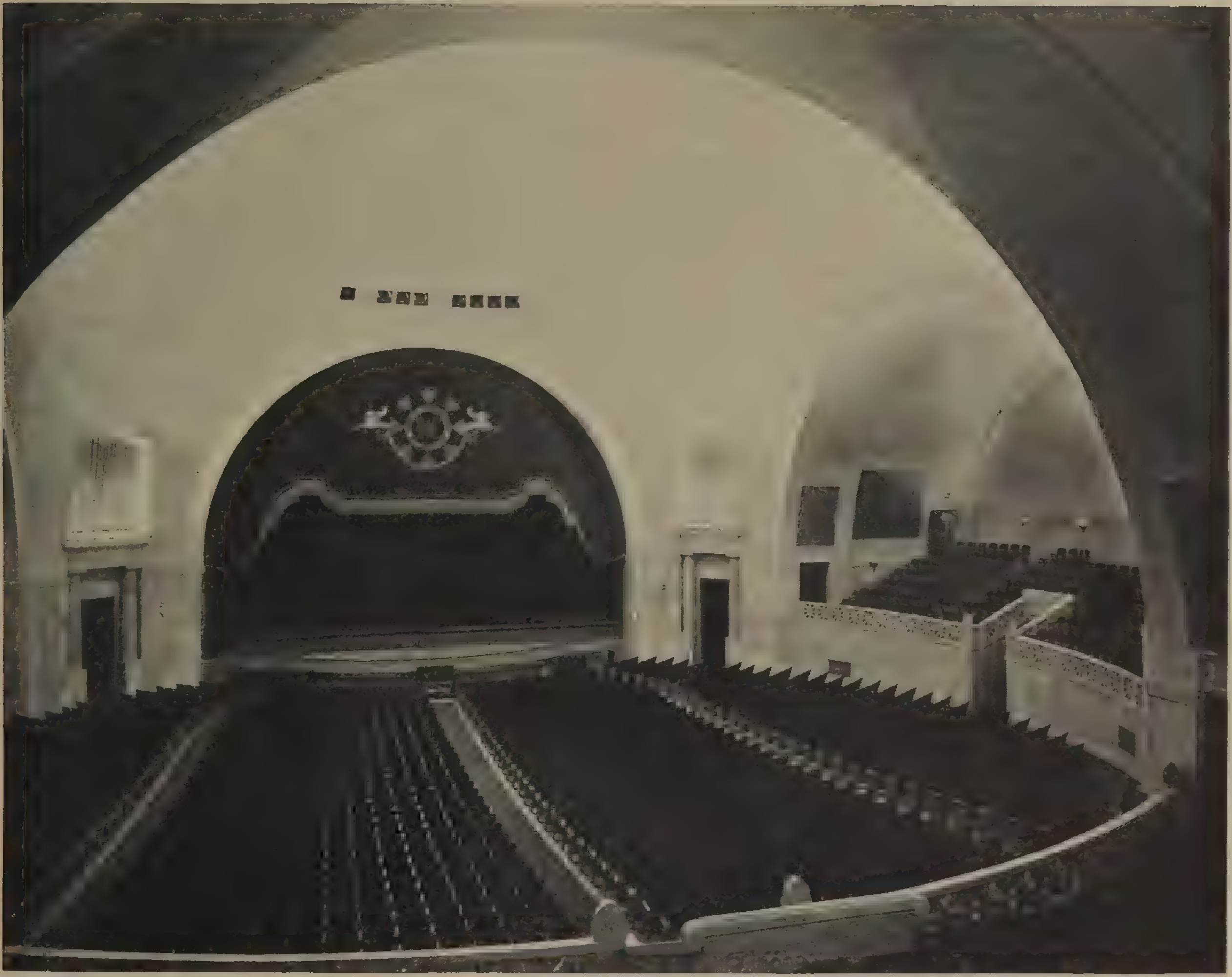


FIGURE 55—An excellent example of modern lighting. The main auditorium of the War Memorial Building, Louisville, Ky. Carrere & Hastings, Architects, New York City, with E. T. Hutchings, of Louisville, Associate. Illumination combines use of a center ceiling skylight and special cove and pedestal lighting with X-Ray reflectors.

Artificial lighting will become a very prominent and essential element in building design. It may frequently become a most important element in the decorative scheme. We already have examples of extensive luminous building areas, glowing columns, lintels and ceiling surfaces, all of which are typical of the so-called "architectural lighting."

The lighting specialists and architectural designer are finding new fields in which to exercise their imagination, not only in methods of application, but also in the discovery of new purposes and uses for artificial light.

Economic Value of Lighting

We have found that good lighting has immensely beneficial influences in many phases of our every-day life. It is the means of increasing production in industrial plants. It is effective in reducing traffic accidents. It assists school children in the comfortable pursuit of their studies. It adds attractiveness and pulling power to the shop window of the mercantile establishment. In hundreds of ways the advantages of good lighting may be measured numerically and counted in dollars and cents. Good lighting has many by-products of very important economic value.

A manufacturer in Cincinnati installed improved lighting in his plant and immediately noted a marked improvement in production, aggregating fully 10 to 12 per cent. in increased output. The improved lighting soon paid for the cost of making the change. Careful tests in industrial establishments show that for an additional lighting cost in per cent. of payroll of from 1 to 5 per cent. the resulting increased production ranges from 8 to 35 per cent., depending on local conditions.

In a business office where sixty to seventy-five typists are employed much disturbance in the routine of the work was experienced due to the number of absentees, suffering from headaches. The lighting system was changed to Curtis indirect illumination, with a greater intensity of uniform lighting. The man responsible for the installation states that after having used the system for several months fourteen of the girls discontinued the use of glasses and there was a marked decrease in the number of absentees. The work in the department was speeded up, which was sufficient proof that the employees were happier and more contented in their new environment brought about by proper lighting.

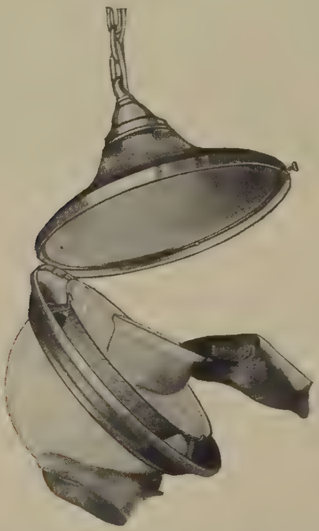


FIGURE 56—A luminaire designed for easy maintenance. The hinged rim of the bowl opens to expose the reflector and lamp.

Lighting Legislation

One of the encouraging tendencies in the application of modern lighting is the fact that the beneficial effects of adequate illumination on the health and safety of the employees of industrial plants have been recognized, and that many of the states have adopted codes, or regulations which specify minimum requirements. As a rule, the codes stipulate the least amount of illumination permitted for certain classes of industrial plants. They also indicate the desirable as distinguished from the minimum illumination values, and the kinds of lighting equipment which should be used to avoid glare and give a good distribution of light.

The original code for lighting of factories, mills and other working places was prepared and issued by the Illuminating Engineering Society, in order to make available authoritative information for legislative bodies, factory boards, industrial commissions and others who are interested in enactments, rules and legislation for better lighting. The code is intended also as a guide to factory owners and operators in their efforts to improve lighting conditions in their manufacturing plants and other work areas.

Insufficient and improperly applied illumination is known to be a frequent cause of industrial accidents. Mr. R. E. Simpson, of the Travelers Insurance Company, gives some very interesting data on the subject of the relation between light and safety. The following is quoted from one of his articles:

"There is some foundation for assuming that 18 per cent. of our industrial accidents is due to the defects in lighting installations. On that basis the services of 108,000 men for one year are lost annually because the illumination provided is not adequate for the safety of the workman. That this condition could exist year after year is all the more reprehensible, because of the fact that the remedy is so easily applied and has beneficial results in many other ways than the safety involved. Accidents caused by carelessness, inattention or ignorance can be eliminated only by a long-continued, painstaking educational campaign, often involving a change in long established habits. Elimination of accidents due to inadequate or improper lighting is simply a matter of purchasing the proper equipment and installing it under competent directions. In fact, it seems proper to

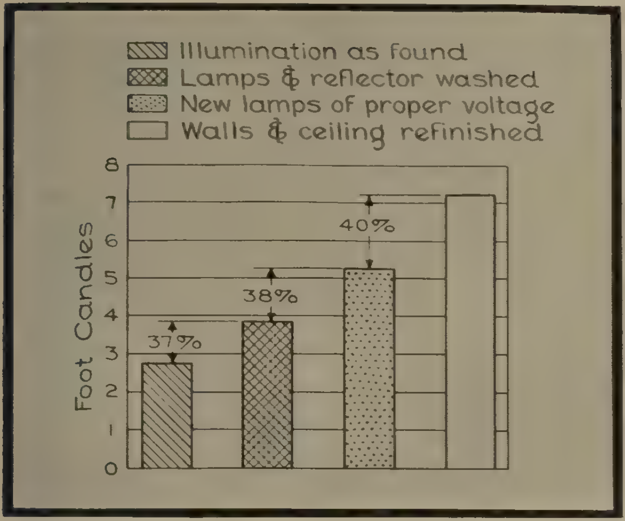


FIGURE 57—A regular schedule for the cleaning of lighting equipment and the renewal of lamps and room decorations will prevent loss of lighting output.

include illumination in the list of mechanical safeguards, for the reason that the lamps and reflectros provide a guard; illumination points out the hazards just as effectively as a railing points out the danger of and provides protection against the hazard of a revolving flywheel."

During the last thirteen years eleven states have adopted codes of lighting for industrial plants. Some have enacted similar rules for the illumination of school rooms.

Maintenance of Lighting Equipment

The cleaning of lamps and reflectors in an artificial lighting system is as essential as the cleaning of any other equipment used in an office, factory, or other establishment. If the cleaning is not systematically performed, such neglect will result in as serious a loss as failing to clean windows through which the daylight filters. The reduction in efficiency caused by films of dust or other material adhering to the glass being gradual, will not be noticed until it occurs to some one that the amount of light on his work is insufficient. It might be realized that the lights should be cleaned; it might also occur that a workman should satisfy his need by replacing some bulbs of the unsatisfactory lighting system with those of higher wattage, in consequence of which more current will be consumed. The lamp which is used for the replacement might not be the proper one for the reflector or other accessory, creating a wrong distribution of light, or unduly exposing the filament, thus bringing about a condition of glare.

In Fig. 57 the results of occasional maintenance are shown in a graphical manner, and indicate the gains in amount of lighting resulting from the cleaning of equipment, the replacing of blackened lamps and the maintaining of the finish of the walls. One fact that is frequently overlooked is the necessity for using lamps of correct voltage rating. Very often 115-volt lamps are burned on a 110-volt circuit, the result being that the amount of light to be expected from the luminaire is not forthcoming because of the fact that the lamp is not burning under proper conditions. The voltage rating of the lamp and the voltage of the electrical circuit should always be the same if maximum efficiency is desired.

We have scarcely begun to realize and take advantage of the many beneficial and interesting ways of utilizing artificial lighting, our most flexible and revealing medium. There is need for more careful study of its possibilities. We have an abundance of subjects upon which to work; we have the technical implements; our need is to put these tools to use. The results of many years of experience in the control of light is incorporated in the examples that are shown on the pages that follow. It is impossible, of course, to illustrate or describe the hundreds of variations of any particular problem. The examples shown are typical and serve to indicate some of the possibilities in the application of Curtis Lighting products, the most efficient of lighting appliances.

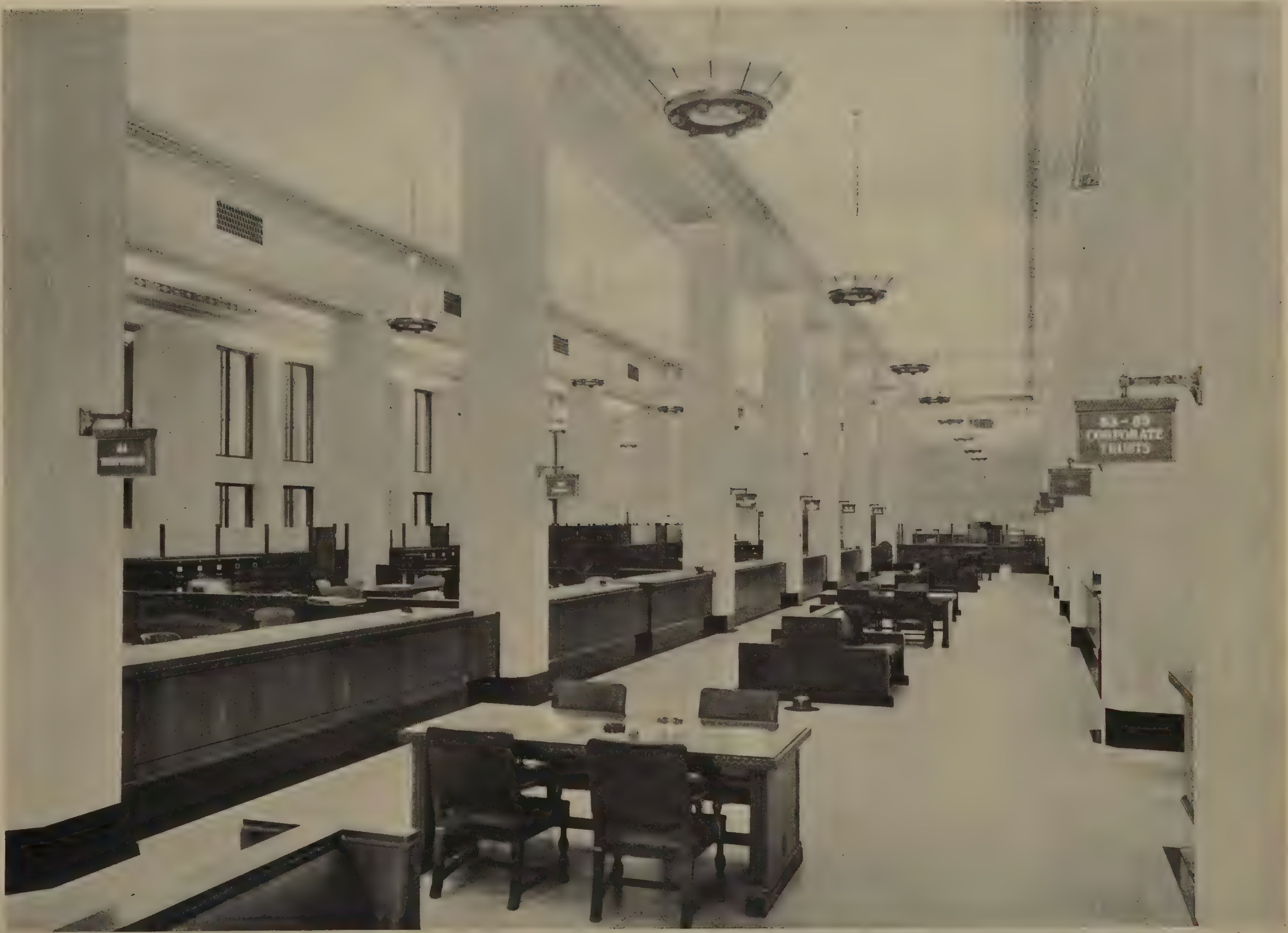


FIGURE 58—The Escrow Department, Title Insurance & Trust Co., Los Angeles. John C. Parkinson, Architect. The luminaires are of especially harmonious design in the modern feeling. Each fixture contains X-Ray silvered reflectors for indirect lighting.

OFFICES

HAVE we not sufficient evidence in the experience and investigations of recent years to establish definitely the fact that proper artificial illumination in offices has a great influence upon clerical efficiency?

The answer is obvious when we consider that light is one of the most basic of human needs, as fundamental as food and shelter. Naturally, if we cannot see properly we cannot work.

On the average we must use artificial lighting in our offices about one-quarter of the time. Dark and cloudy days, gloomy hours in the early morning and late afternoon, fog and smoke are all influencing factors in keeping out the sunlight.

Hence adequate artificial illumination is of prime necessity in every office. The intricate processes of business involve the keeping of careful records, accounting, checking and filing of every sort. Office managers in their attempts to obtain as nearly 100% efficiency as possible are taking advantage of every opportunity and appliance that will contribute to this high standard.

Errors in calculations may be discovered and corrected. It is not so easy a matter to find the losses that are due to bad lighting. The employee may be irritable and careless as the result of improper lighting arrangements. These indirect losses can be minimized by a study of the illumination conditions in the office.

If a small percentage in efficiency of the office force could be realized by a change in lighting conditions, this saving would in a short time more than pay for any financial outlay in making the installation, because of the elimination of errors and the easing of the nervous strain.

The chances for disastrous results due to eye fatigue are very prevalent in most offices where business people spend many hours a day. Fortunately, the means for providing favorable lighting conditions for the desk worker are easily available and economically applied.

Since the primary function of illumination is to promote accurate and comfortable vision, the first requirement of a lighting system should be to provide for this condition. Bright spots and contrasts are to be avoided. Illumination must be evenly and uniformly distributed throughout the space, and the equipment be pleasing in appearance. Good lighting has two outstanding characteristics: it is sufficient in quantity and of proper quality as far as diffusion is concerned.

On the subject of quantity of light, Mr. Roger Babson recently directed the following remarks to thousands of office managers:

"Clerks in many offices will increase their output if they are given more light. Altho American business offices are, on the whole, well illuminated, yet recent tests have shown that doubling the light would earn, through speedier work and

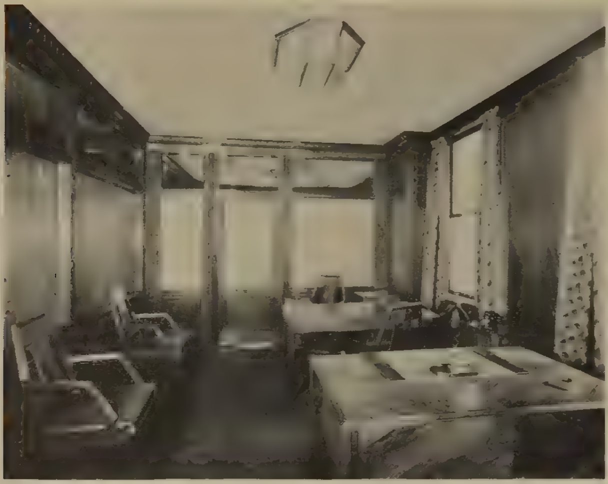


FIGURE 59—Room for Trust Officers, Union Trust Company, Detroit, Mich. Smith, Hinchman & Grylls, Architects. Mr. Wirt Rowland, Designer. Special ceiling lights in modern art design.

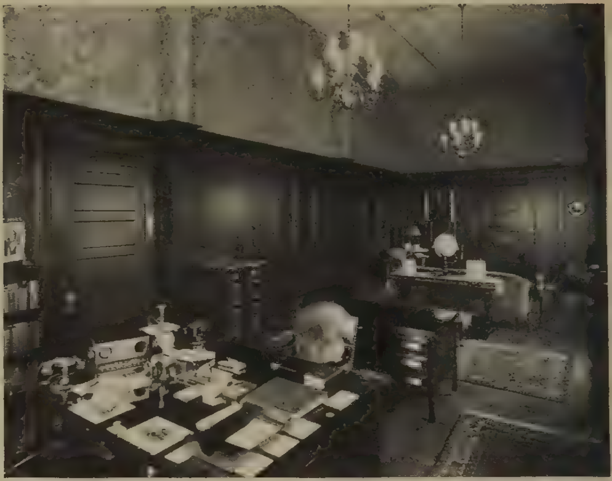


FIGURE 61—Office of the President, Stieff Company, famous silversmiths of Baltimore, Md. The chandeliers in the Flemish style are appropriate for this formal and beautiful interior.

decreased mistakes, at least TEN times the extra cost for electricity.

"Four thousand tests of speed and accuracy in typing from printed copy and in transcribing notes indicated that straight typing would be increased at least 100% by additional lighting, and transcribing output would be stepped up by 20%. Work requiring still more accurate use of the eyes, like bookkeeping, filling out blanks, searching through indices or drafting of any kind, would be still further speeded by plenty of light.

"One drawback to improvement in lighting arises from the fact that conditions often appear to be satisfactory and no requests come from the workers for extra illumination. It is up to the office manager to study the lighting requirements, and if he takes the initiative along this line, any expenses will be quickly repaid by the increased efficiency of his workers."

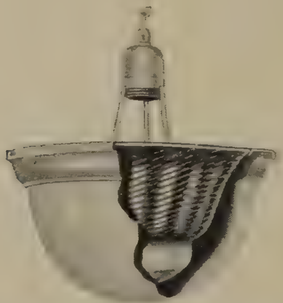


FIGURE 60—Typical X-Ray luminaire for office lighting. The glass bowl contains an X-Ray silvered reflector and diffusing cup for lighting the outer glass enclosure.

Perhaps the most severe test that a lighting system has to meet comes from great corporations in whose employ are engineers and efficiency experts who pass on all equipment and by rigid competitive tests decide upon the type to be installed. In such instances indirect lighting has come out triumphant in competition with other systems.

When used for office spaces indirect lighting affords numerous economies. For example, the cost of wiring and luminaire equipment in many cases is reduced because of the large areas that may be illuminated with a single indirect fixture. Another economy is effected because of the fact that the arrangement of the furniture in the office using indirect lighting is entirely independent of the disposition of the electrical outlets. Indirect lighting is not suited to all types of offices, for example, glass ceilinged rooms or interiors with dark ceilings, except where it is desired to enhance or reveal architectural detail.

The typical equipment for commercial indirect lighting in offices and drafting rooms consists primarily of pendant luminaires, usually supported from the ceiling. However, equipment for cove lighting, lighting from columns, moldings, wall brackets and pedestals is frequently applied when the conditions are suitable. Pendant luminaires

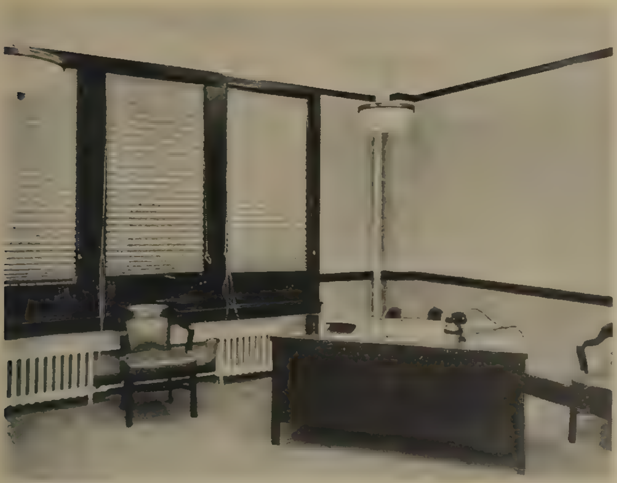


FIGURE 62—Private office, Public Service Company of Northern Illinois, Joliet, Ill. H. V. Von Holst, Architect. Note the absence of glare and even distribution of light from the luminous indirect lighting fixture.

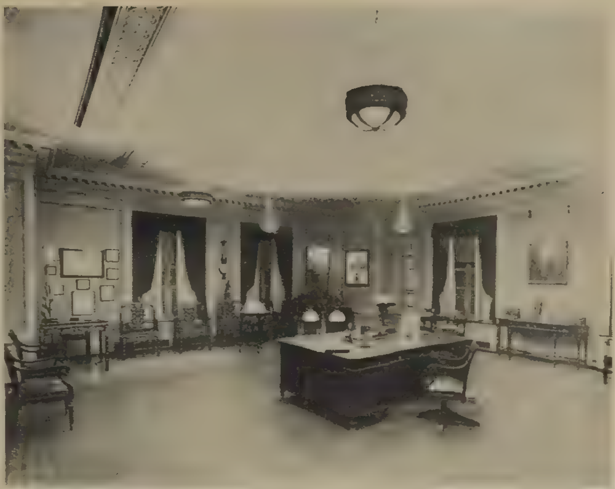


FIGURE 63—Office of the Mayor, City of Pittsburgh, Pa. Long continued conferences may be held without annoyance of glare frequently found in rooms of this character. The fixture arrangement conforms to the ceiling panel design.

contain reflectors either for a single or a multiple of lamps, and are obtainable in metal, glass, or of composition material.

Private Offices

In private offices the conditions for a high utilization of the lighting are less favorable than for general offices. Frequently two or more sides of the room may be considered as being made primarily of glass. Windows occupy nearly all of the exterior wall space, and the other three sides, in many cases, are of clear or obscure glass from the bottom of the ceiling beams down to a point a little above the desk level.

Under these conditions it is necessary to provide more wattage for each unit area than for general offices. When the luminaires in adjacent offices are being used we may expect some assistance in the way of "borrowed" light that passes through the glass partitions. In planning the lighting, however, this increase in intensity from adjacent areas should not be depended upon. In large private offices the amount of light delivered at the desk top, in proportion to that developed by the lamps, is proportionately greater than for the smaller office.

In the office of the Stieff Company, Baltimore, famous silversmiths, an attempt has been made to provide furnishings of unusual quality. The illustration in Fig. 61 shows the private office of the president, and indicates how the proper atmosphere in lighting is obtained by means of a 10-light 2-tier cast brass luminaire designed in the Flemish pattern, finished in old English brass, and with Tudor designs upon the parchment shades.

In contrast, a typical private office of the Union Trust Company, Detroit, as shown in Fig. 59, exhibits purely modern type of interior with lighting in harmony. The severe lines of the decorative treatment are reflected in the ceiling fixture, which is constructed of flat glass panels of highly diffusing character.

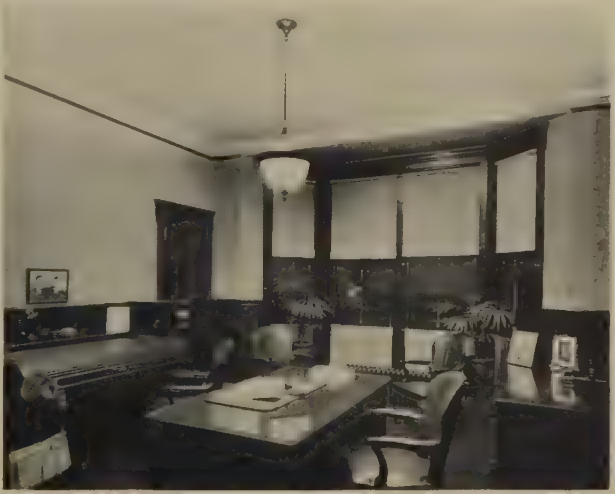


FIGURE 64—Private office of the Vice President, Kee-Lox Mfg. Co., Rochester, N. Y. Leander McCord, Architect. The indirect luminaire is in harmony with the high quality of the furnishings.

Probably the most popular style of lighting fixture for offices is the luminous bowl indirect unit. The bowl is of glass, as shown in illustrations 62, 63 and 64, and conceals a reflector and a diffusing cup. The purpose of the diffusing cup is to evenly illuminate the glass bowl to a pleasing brightness. In many offices the psychological value of the brightly lighted bowl is desired.

General Offices

In the installation pictured in Fig. 58 we have a beautiful example of how a luminaire of the indirect style may be considered as an integral part of the architectural design of the room. It is evident that the architect sought to avoid the "afterthought" effect of the usual methods in illumination, and insisted on a luminaire that would lend itself to the restrained treatment of his interior design. The fixture is particularly interesting because of its symmetry, its simplicity and beauty. It consists primarily of a metal ring ornamented with rosettes and supporting a series of diffusing glass plates at a graceful angle around the periphery of the ring. The panels are luminous, as is also the glass disked bottom of the fixture. An interesting ornamental "break" in the support of the fixture adds variety and echoes the motif carried out in the design of the glass panels.

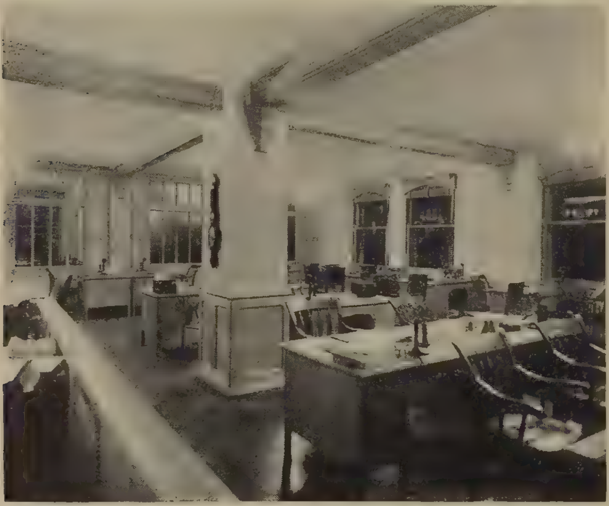


FIGURE 65—General office, Blyth & Company, Boston, Mass. George Clark Whiting, Architect. Modern, efficient lighting of truly Colonial design.

It has been found that lighting has a very decided influence upon the renting value of a building, therefore building owners and business managers are giving study to the improvement of lighting conditions. They are discovering that better lighting is not an expense, but an investment which yields a rich return.

No doubt the office manager is frequently bewildered as to what course to follow in the selection of a lighting system for his building, because of the various types of equipment and systems that are offered for his consideration. His problem would be much simplified if he were to make a careful study of the essential requirements of

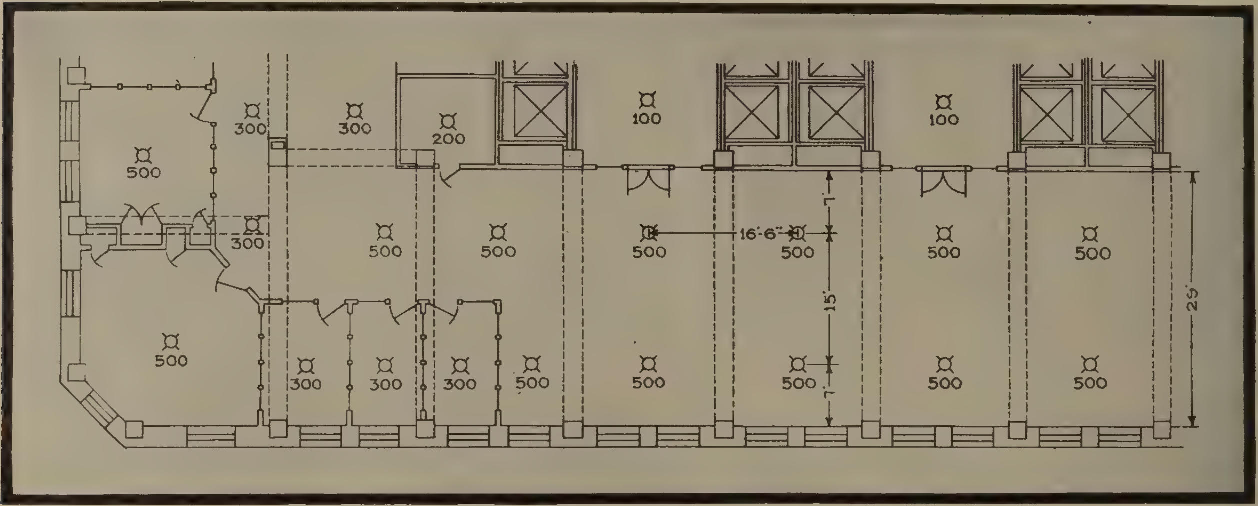


FIGURE 66—A plan of a typical general office space showing the location and wattage for the electric lighting outlets.

his particular office space and determine what might be expected in the results from the various systems recommended.

For the office of Blyth & Company, Boston, George Clark Whiting, the architect, has worked out something of unusual character. A very pleasing atmosphere has been created in this office by specially designed desks, chairs and interior woodwork. To be in harmony the luminaires must, of necessity, be of correct design. In this instance a truly early Colonial style was adopted, which, in addition to giving satisfactory illumination, forms an important item in the furnishing of the office.

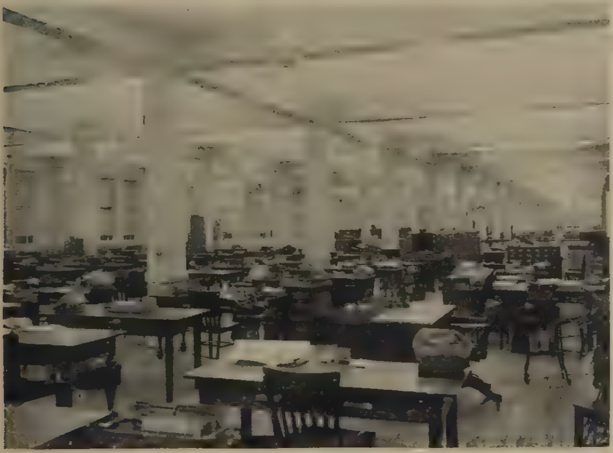


FIGURE 67—General office of the Maryland Casualty Company, Baltimore. Otto Simonson, Architect. Good illumination is needed in the auditing department for greatest desk-efficiency.

The officers of the Maryland Casualty Company, of Baltimore, are convinced that if there is one office in any establishment that needs good illumination, it is the auditing department. That strict attention has been given to this important detail may be seen by observing in illustration No. 67, the totally indirect lighting system installed in that department. Here the workers are well housed; the proper spacing and alignment of desks has been carefully planned. With 344 totally indirect units employed, each containing a 500-watt lamp, there is no specular reflection from the desk tops, office stationery or polished typewriting machine surfaces. The company set forth to establish the maximum of comfort for its great number of employees. That it really pays the employer is proved by office statistics, which show that a greater desk efficiency per employee has resulted since indirect lighting was adopted.

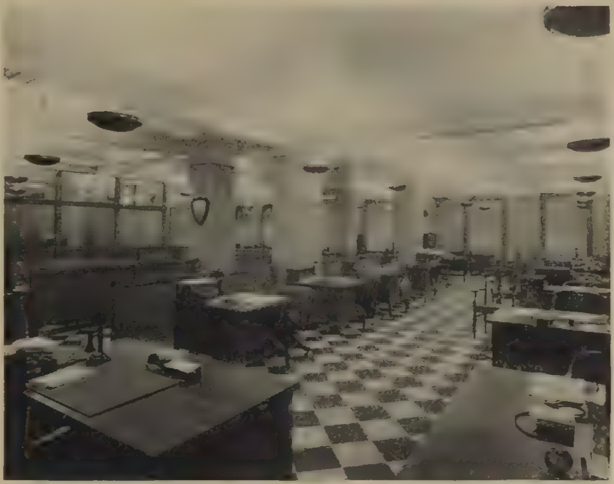


FIGURE 68—The general office of Cassett Company, Philadelphia, Pa. The metal bowl luminaires each contain three X-Ray reflectors for 150-watt lamps.

The modern tendency in office lighting is illustrated in Fig. 68, an interior in which a high intensity of illumination is employed. Orderly appearance and arrangement are easily maintained when good lighting is used. In fact, efficient business demands efficient lighting.

The methods employed by the central station in the lighting of its own building have an important effect upon the use of artificial lighting by its customers. The officers of the Detroit-Edison Company had this point in mind in selecting the system that is now in use in their own building. There were other points, however, that were given careful consideration. The method finally adopted must be characterized by an absence of glare that might cause eye strain.

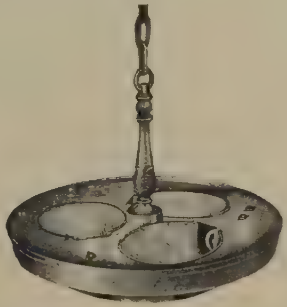


FIGURE 69—The luminaire employed for the lighting of the Cassett Company offices illustrated in Figure 68.

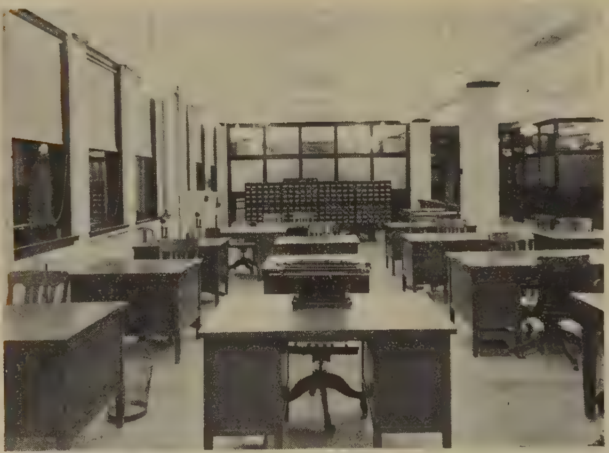


FIGURE 70—General office Detroit Edison Company, Detroit, Mich. Smith, Hinchman & Grylls, Architects. This office is typical for the entire building, which is illuminated with 5100 units of the indirect type, using X-Ray reflectors.

Before making the final selection of the lighting system that was eventually adopted, the Detroit-Edison Company made representative installations of various types of commercial lighting equipment. Units were installed in typical areas where the room dimensions, decorations, and furnishings were identical for each type. Thus an opportunity was afforded to study the cost of operation, cost of maintenance, the intensity of light delivered, the glare effects, and seeing efficiency of each type.

It was found that uniformity of diffusion of the light was a far greater variable than the average intensity obtained from the various types of units. This factor ranged from 20% variation for the totally indirect lighting to 100% for some of the other lighting types. It was considered important in this instance that the maximum uniformity of illumination be obtained, inasmuch as the outlets were arranged irrespective of the location of the partitions and office equipment. After completing exhaustive tests indirect lighting was selected and was installed throughout the building.

The type of luminaire chosen is easily maintained. When the fixture is to be cleaned it is only necessary to loosen one of the spring arms holding the bowl and allow it to swing down on the other two arms. The smooth glass surface of the reflector and lamp may then be easily wiped with a damp cloth and the bowl again fastened to the arm. Incidentally, the maintenance of equipment is on a regular schedule, insuring periodical cleaning and a maximum of lighting efficiency.

An interesting example of the economy resulting from the minimizing of eye strain was recently reported in the System Magazine. The International Magazine Company, of New York, experienced many complaints from headaches and eye strain in the stencil-cutting department. An indirect system of illumination was installed and a test was made to determine what effect the new lighting might have upon the productivity of the working force. The results of the test are recorded below:

First week after moving (before new lighting was installed) productivity of the department dropped	5%
Second week after moving (new lighting installed) productivity returned to normal despite the constant hammering of carpenters and electricians	0%
Third week after moving (alterations still going on, new lighting in use) productivity increased	5%
Fourth week after moving (alterations still in process) productivity increased	8%
Fifth week after moving productivity stationary at increase of	8%
Sixth week after moving productivity increased	10%

The Union Central Life Insurance Company, of Cincinnati, is one of the several buildings in which totally indirect lighting is being used for all offices. It is not now rare for a building in which space is to be rented to be so equipped. The decision to adopt the recommendation for this type of lighting was reached only after the building committee had inspected and tested all suitable types of equipment for office illumination. The unit finally approved and installed is known as the "Winall" fixture. The Union Central Building was the first to adopt this particular style, which is illustrated in Fig. 72. The Winall fixture is identical in its general principle with the luminous

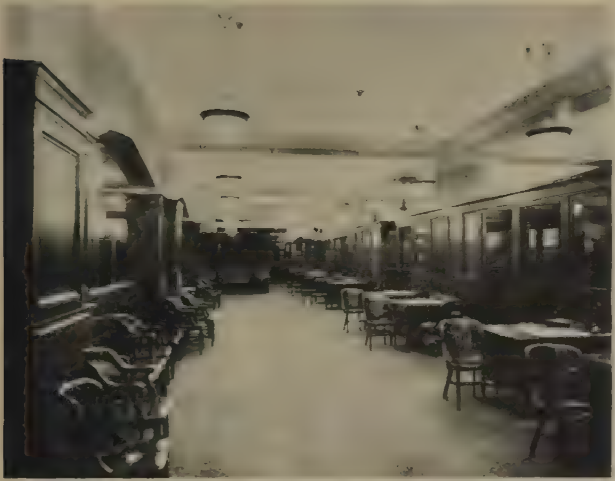


FIGURE 71—Office of J. L. Hudson Company, Detroit, Mich. Smith, Hinchman & Grylls, Architects. Ceiling is of the acoustical type in light finish, entirely suitable for indirect lighting installations.

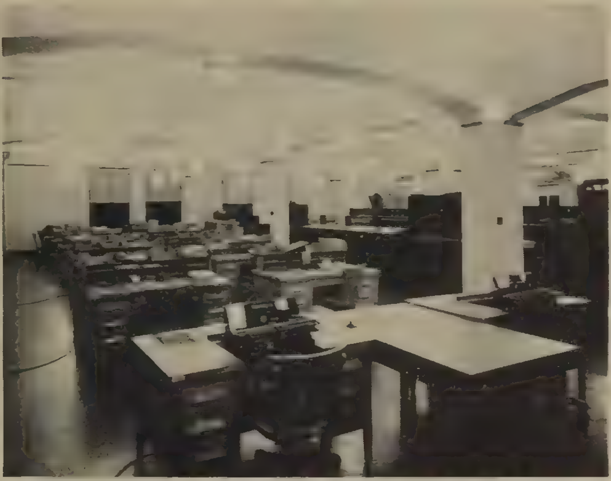


FIGURE 73—General office of Union Central Life Insurance Company, Cincinnati, Ohio. Garber & Woodward, Architects. The "Winall" fixture as illustrated in Fig. 72 is employed throughout this building.

bowl shown in Fig. 60, with silvered reflector and diffusing cup incorporated within the glass bowl of the fixture. In addition it has the desirable feature of a dust cover, which simplifies maintenance by minimizing dust and dirt accumulation on the reflecting elements.

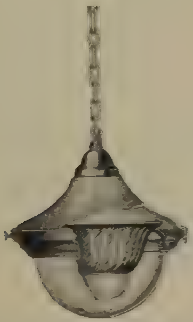


FIGURE 72—The Curtis "Winall" luminous bowl fixture with dust cover equipped with X-Ray reflector. This style is designed for use with 200-watt lamps.

Tests by independent authorities on the Winall fixture indicate a very high efficiency of light delivery. In the particular installation shown in Fig. 73 the use of 1.6 watts per square foot of floor area gives an average of about 10 foot-candles in lighting intensity.

Various types of luminaires are employed for lighting the offices of the Ottawa Electric Company. One of the units selected is shown in Fig. 74. The bowl containing the reflectors which give the general indirect lighting for the space is made of "Compone," an especially durable composition, and supported from the ceiling by means of six rods. The illuminated panels are of white opal glass, giving a warmth to the lighting unit so characteristic of the Curtis "luminous bowl" unit. For the illumination of these panels low wattage lamps only are required, inasmuch as the transmitted light is not depended upon for the illumination of the room, but only to give a pleasing appearance to the fixture. The interior arrangement of the luminaire provides for six X-Ray silvered reflectors of the indirect lighting type.

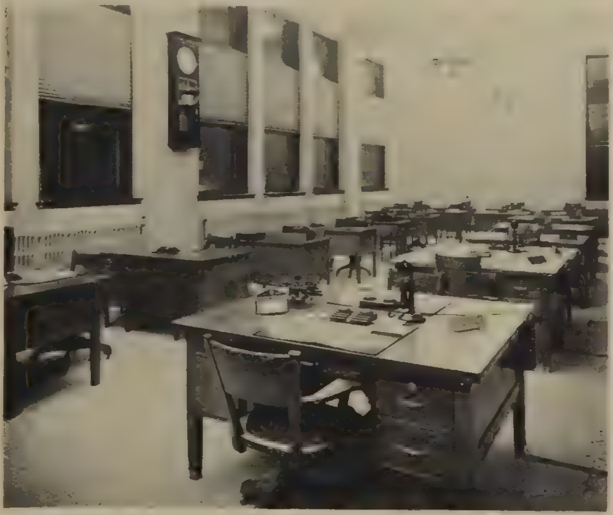


FIGURE 74—General office, Ottawa Electric Company, Ottawa, Canada. Each fixture contains six lamps with silvered reflectors for indirect lighting.

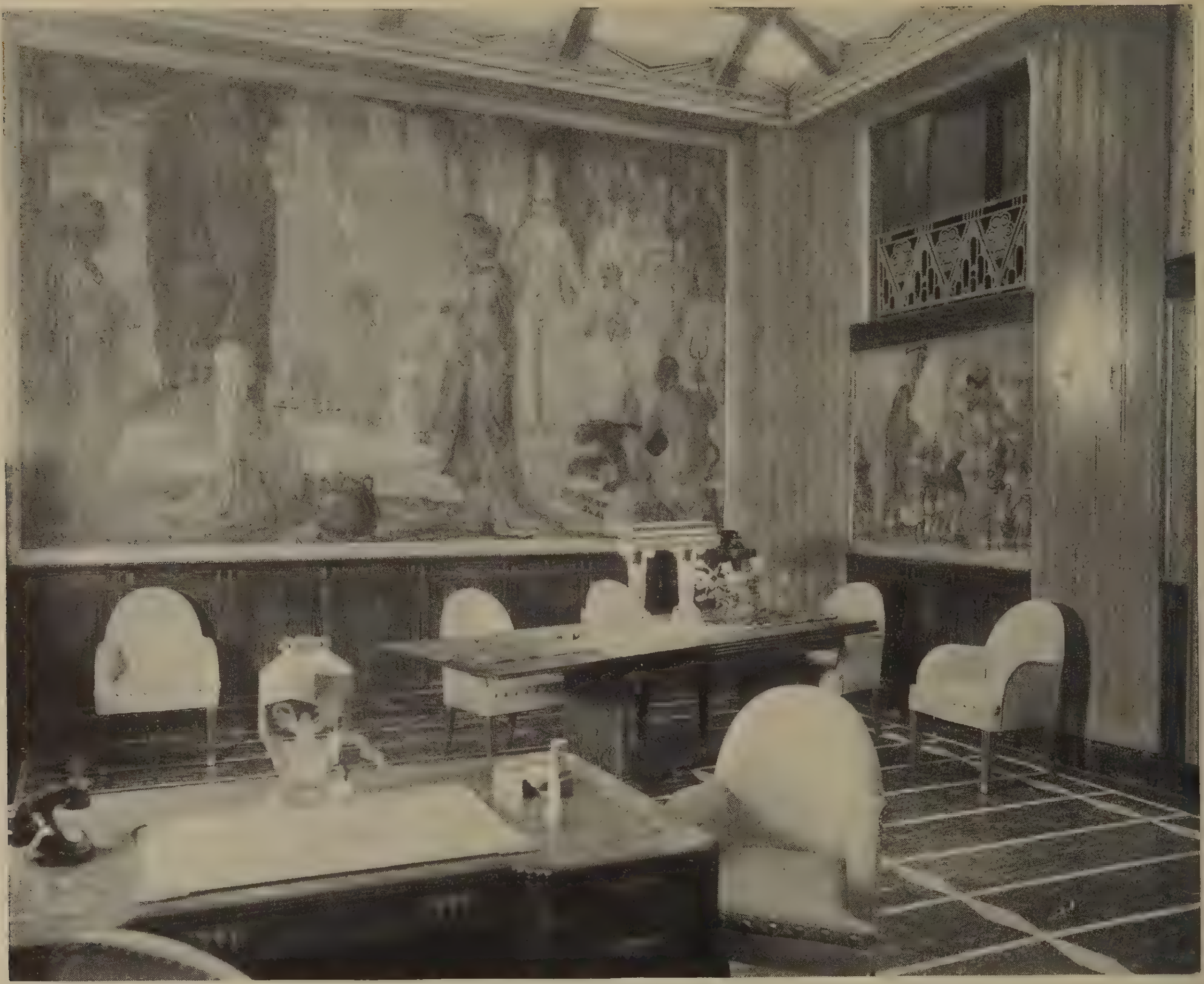


FIGURE 75—*Conference room, Guaranty Building and Loan Association, Los Angeles, Feil & Paradise, Designers. Note unique method of lighting from special cove.*

Conference Rooms

In considering the illumination of offices there is frequently a tendency to overlook the fact that the conference room should have illumination of particularly restful quality. Too often glaring side wall brackets, or decorative chandeliers with numerous exposed lamps, are installed in this important room, resulting in a very detrimental effect upon the conference. Drowsiness, lack of attention, and slowness in arriving at important decisions are by-products of improper lighting.

Comfortable illumination should have our first consideration. Then the artistic lighting touches may be added. Wall brackets should be well

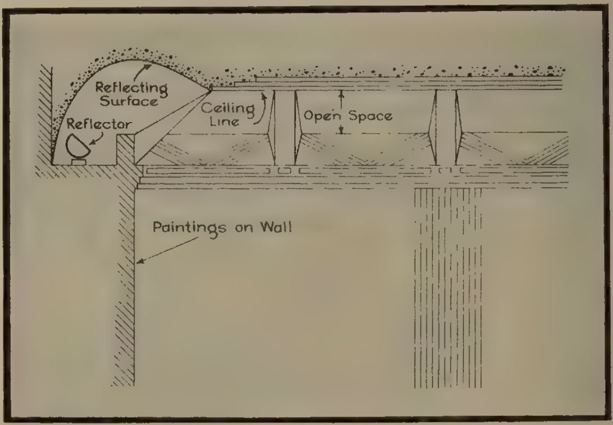


FIGURE 76—*Diagrammatic scheme of method used for the Guaranty Building and Loan Association, Los Angeles, illustrated above.*

shaded, equipped with lamps of small wattage to avoid over-brightness, and not be depended upon to supply the principal lighting component.

The use of luminaires pendant from the ceiling is the more generally applicable method of lighting the conference room. Successful examples are shown in Figs. 77 and 79. The former illustrates the use of luminous bowl indirect fixtures in an American banking house, while the latter indicates the results obtained with an opaque indirect luminaire in an English business establishment.

A very successful and most unusual method of illumination for the conference room is that of sky-lighting. The construction of the building frequently permits of the utilization of daylight through a glass ceiling. When artificial lighting is needed, the daylight quality of diffusion may easily be obtained by proper arrangement of reflectors and lamps above the skylight. A particularly agreeable lighting quality results by this means if judgment is used in the selection of the accessories and the glass for the ceiling.

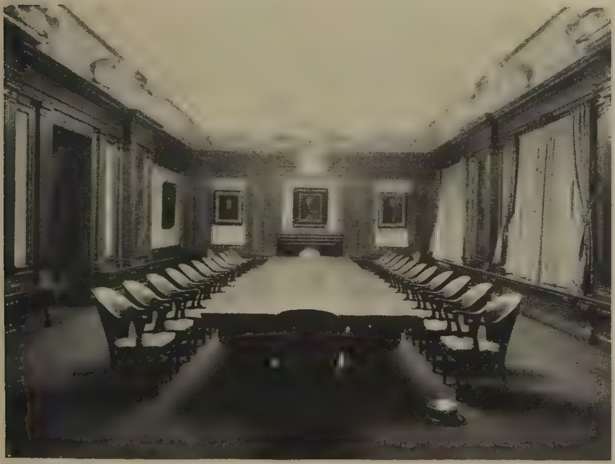


FIGURE 77—Conference room, First National Bank, Chicago, Illinois. Leonard Construction Company, Architects. Luminous indirect lighting fixtures provide a comfortable atmosphere.

Since considerable thought is usually given to the architectural design of the conference room, cove lighting can frequently be incorporated without essentially changing the decorative feeling of the room. Fig. 75 is typical of conference rooms in which the cove lighting method is utilized.

The design, by Feil & Paradise, of the Guaranty Building and Loan Association, is typical of the modern tendency in interior construction and finish, and furnishes also a very interesting example of the so-called "built-in" lighting. In this particular instance what might be termed a recessed-cove lighting scheme has been adopted which is more clearly shown diagrammatically in Fig. 76. It may be noted that silvered reflectors direct the light from the lamps against a diffusing plastered surface, from which the light is cast uniformly over the beautiful mural decorations and reflected into the public space.

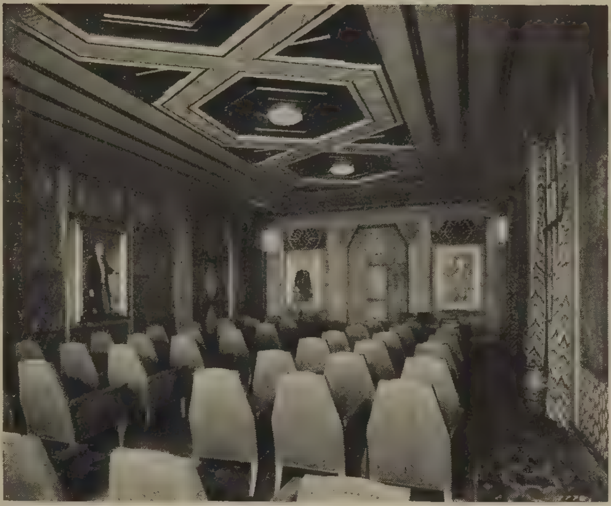


FIGURE 78—Directors' room, Union Trust Company, Detroit, Mich. Smith, Hinchman & Grylls, Architects. Special ceiling units in modern design are used with luminous fittings in corners of the room.

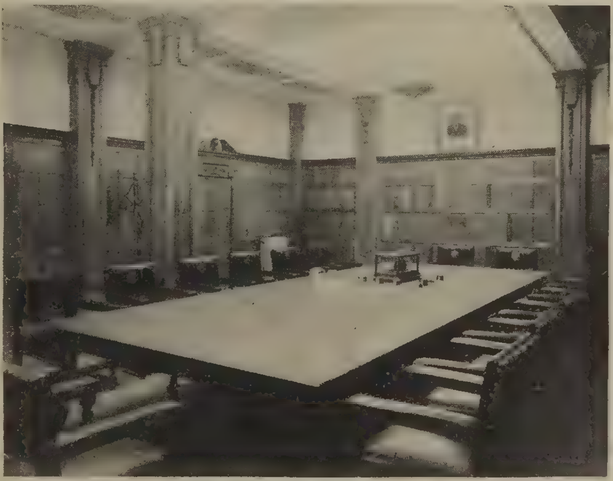


FIGURE 79—Conference room, Hartlepool Cooperative Society, London, England. Installation by British Thomson Houston Company. Opaque indirect luminaires of metal in plain design harmonize with this formal interior.

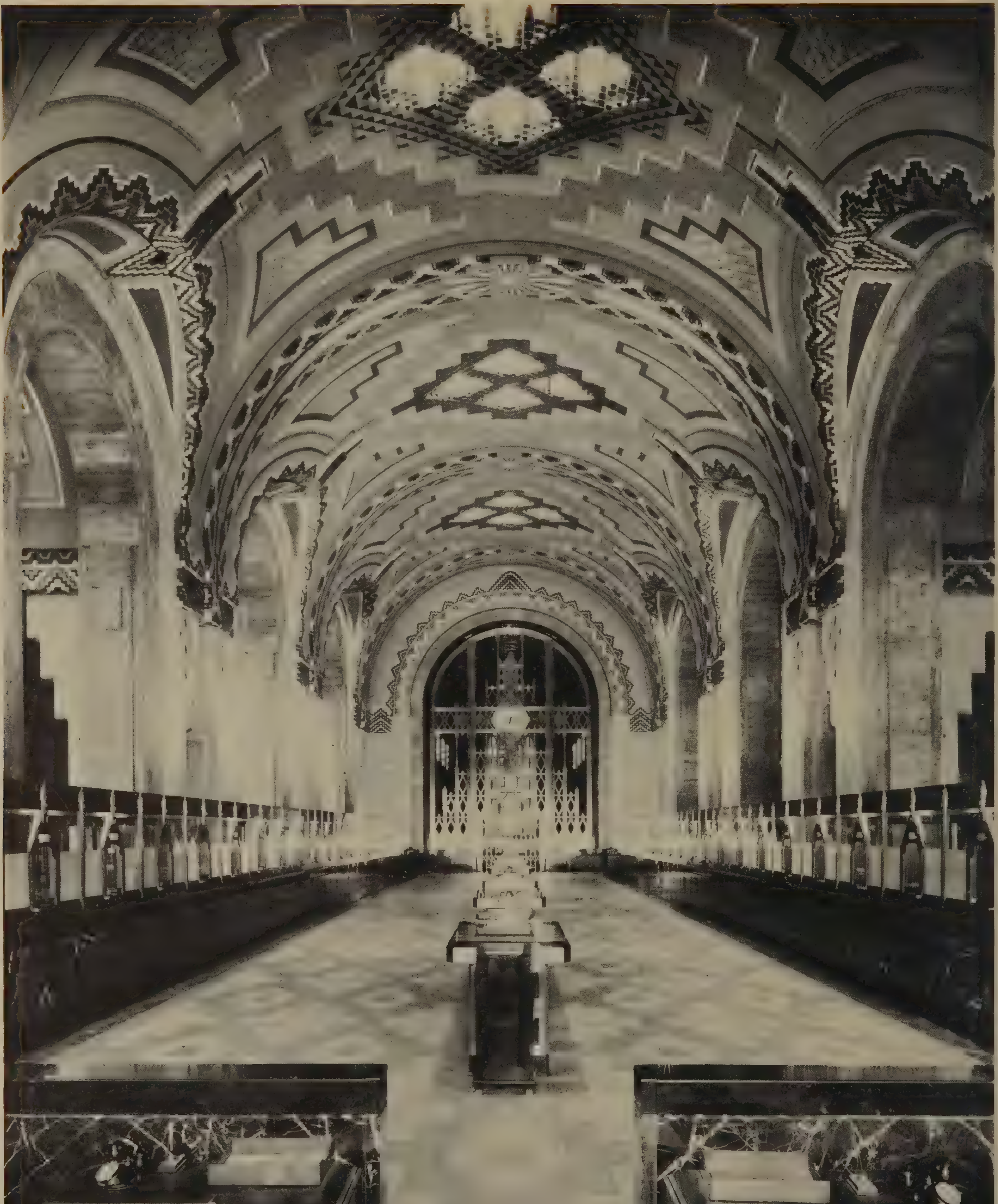
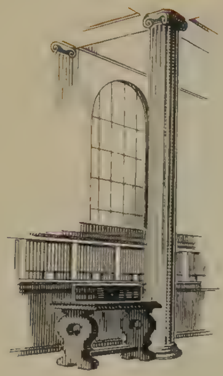


FIGURE 80—The Main Banking Room, Union Trust Company, Detroit, Michigan. Smith, Hinchman & Grylls, Architects. Principal illumination comes from tops of the banking screen supplemented by luminous panels of glass in the ceiling.



BANKS

THE financial center of a community must have imparted to it by architectural treatment and by furnishings an atmosphere of conservatism, refinement and dignity, entirely lacking in garish display or in anything that might give a suggestion of unsoundness. The entire scheme, especially of those portions of the banking house frequented by the public, proposes to impress the customer or the prospective client with the solidity of the institution, thus creating a feeling of trust and confidence so essential to its existence and healthy growth. The bank as a building has a very important influence upon the other public buildings of the community.

The day has gone when the banker wants his building to look like a fortress, as if it were impossible to get into and to get out of. In the old days the bank president received callers in seclusion in a remote corner of his institution. Now the thought is to give him and other officers a position of prominence actually as near the front door as possible. In addition to changes in its relation to the public banks of this country have undergone great changes from the architectural standpoint. Methods of design that were employed twenty years ago are now out of date since an entirely new expression has come into the designing of bank buildings both for the interior and exterior. This new note is largely one of simplicity of treatment and concentration of architectural detail to relieve the severity of plain and unbroken wall surfaces. The tendency towards simplification in bank design is particularly noted in the work of the younger architects.

Interior arrangements have also been radically changed. More thought has been given to the disposition of the public space in reference to the working space. We find that the bank plan usually consists of one of three typical styles—the "U"

FIGURE 81—The money broker is the primitive banker, with scales and trays of native and foreign coins, he lives by his wits.

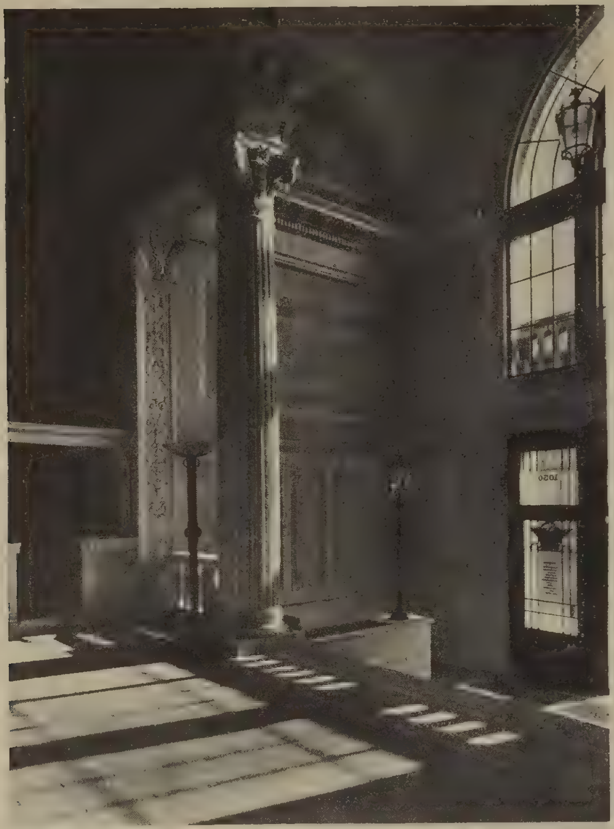


FIGURE 82—An attractive bank entrance utilizes artistic luminaires and a flood of light to welcome the patron.

plan or horseshoe plan, the island plan or half island plan. National banks and trust companies are partial to the horseshoe type. The savings banks, however, prefer the island type because the working force is then more closely related. As for the architectural effect the horseshoe plan gives much finer results. Because of its open character it gives a clear unobstructed view of the room whereas the island plan not only blocks the view but has the disadvantage of splitting the public space into two parts. Whichever plan is encountered its influence upon the scheme of illumination to be recommended must be carefully considered.

The lighting system of the banking room should, of course, be in harmony with the general treatment of the interior. It should bring out the architectural beauty; it should create a comfortable and attractive atmosphere; and, furthermore, it should be a system which will provide illumination of proper quality and quantity, and of the correct intensity for the working spaces. Lighting should be considered as a definite business asset in the bank. The banker realizes that customers should be made to feel that they are conducting their business relations in a helpful institution whose interior should actually be cheerful and friendly. Correctly applied illumination engenders an atmosphere which creates this favorable impression. The bank is one of the most elaborate types of public buildings with lighting requirements which are rather special in many departments and similar to those of the usual commercial buildings in other departments.

The primary use of light in the bank is for the supplying of adequate working illumination. Light is also used for purposes of advertising, for the producing of an "atmosphere," for revealing the artistic features of the interior and exterior and for protection of the bank after daylight hours. The importance of good lighting has become increasingly necessary for the branch or neighborhood type of bank because of the fact that the banks are opening their doors at night one or more evenings a week for the accommodation of their "day working" clientele. In spaces where no daylight is available, an artificial lighting system must of necessity be depended upon entirely. In such cases the strictest attention

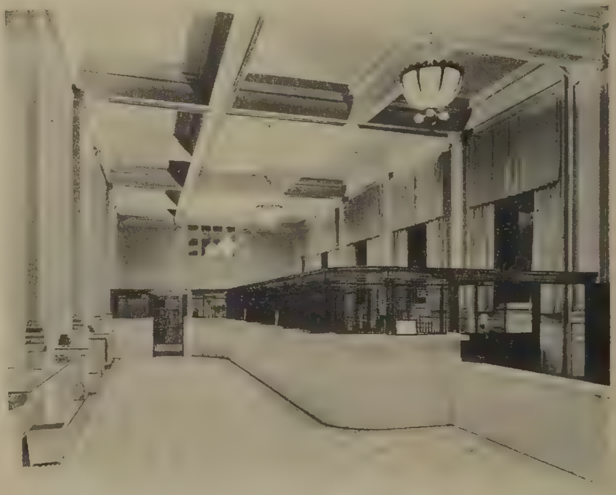


FIGURE 83—Power City Bank, Niagara Falls, N. Y. The luminous fixture suspended from the ceiling panels supplies good illumination for a public space.

should be given to the illumination design to insure proper intensity, best diffusion and avoidance of glare-strain.

The character of the welcome extended to the customer is sometimes entirely determined by the kind of lighting installed. For the entrance, luminaires should be employed, not only because of their light-giving qualities, but also for their artistic value in producing a proper atmosphere.

The public space or main banking room is the department most frequently visited by the patrons, and the one that receives the most elaborate treatment from the decorative standpoint. The illumination of this area assumes great importance, first that the beauties of the decorative scheme should be revealed, second, because of the necessity of providing adequate lighting for the bank's patrons.

The trend is toward the use of concealed lighting, as shown in Fig. 80, for the general public space or main banking room. However, when luminaires are required or desired, special designs are in most cases necessary because of the bank's individuality. Very seldom can the ordinary commercial fixtures be employed if harmony from the artistic standpoint is to result.

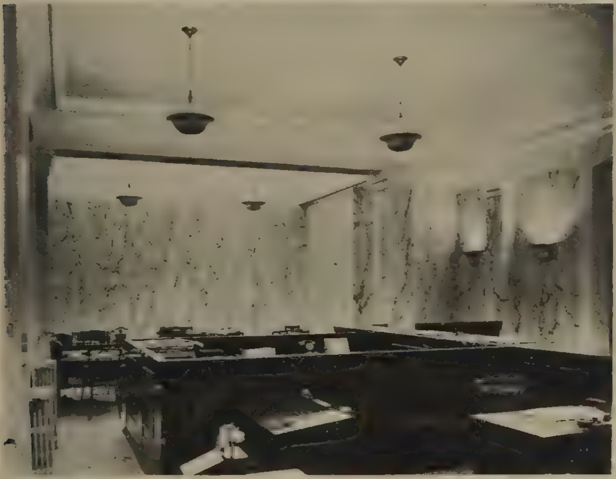


FIGURE 84—Banque Weyl et Sauerbach, Paris, France. Indirect lighting from the ceiling luminaires is supplemented by wall urns containing silvered reflectors.

Attractive and practical lighting results may be secured in a variety of ways. Banks may be lighted by means of fixtures suspended from the ceiling, from special lighting boxes on walls and at other locations, from units in the top of the banking screen, or on partitions, through skylights, or from brackets on posts and pilasters.

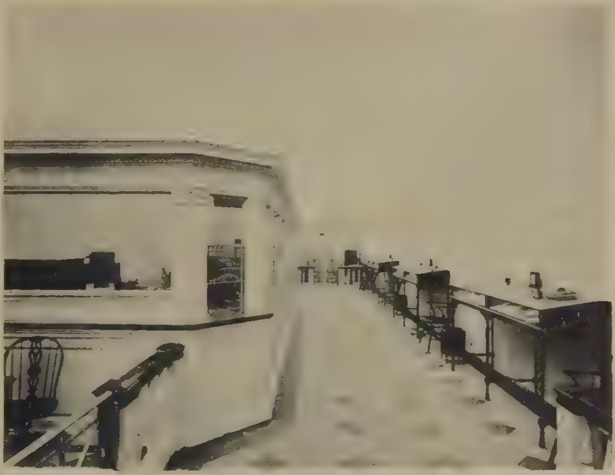


FIGURE 85—Southwark Bank, Philadelphia, Pa. Mellor, Meigs & Howe, Architects. Lighting is from equipment concealed in the top of the banking screen.

The reproduction in Fig. 83 is that of a typical moderate sized bank, decorated in a pleasing manner in light tones. A simple and logical treatment of the lighting problem is suggested by the manner in which the ceiling is divided architecturally by beams. By suspending a luminous fixture of harmonious design from the center of alternate ceiling panels, very gratifying results are obtained. Other arrangements or fixtures may be readily suggested by architectural conditions

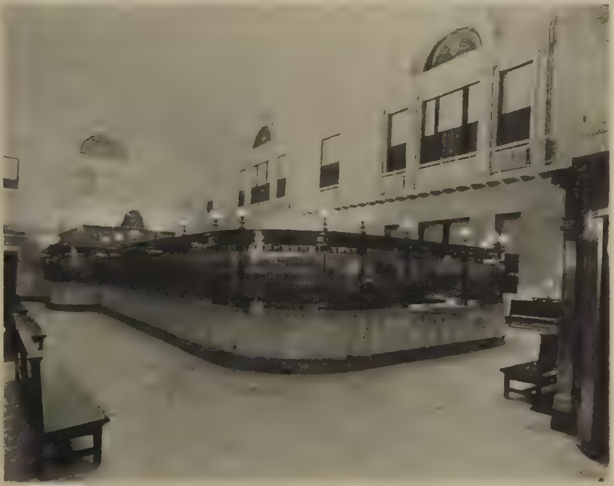


FIGURE 86—Eutaw Savings Bank, Baltimore, Maryland. Taylor & Fisher, Architects. Lighting units concealed from view on top of the vault.

or by some special features peculiar to the particular area or space under consideration. Each condition or set of conditions has a claim for thoughtful study, if proper luminaires and lighting effects are to be secured. A layout ideal as to luminaires may be entirely inadequate when judged by standards of good lighting, or a room well illuminated may be spoiled by the use of inappropriate fittings or fixtures.

The most interesting and often the most harmonious results are obtained by entirely discarding the suspended fixtures. The example of Fig. 85 illustrates how the lighting and the architectural arrangement may be co-ordinated. Lamps and reflectors are placed in the top of the banking screen, with the result that adequate lighting is afforded and with a distinctive effect. The absence of ceiling fixtures gives an effect of spaciousness, otherwise not to be obtained.

A frequent method of lighting for banking interiors is by means of a skylight, such as illustrated in Fig. 88. The daylight effect may be approximated at night by suspending lamps and reflector units above the glass ceiling. Skylight illumination is very desirable because of its attributes of good diffusion and softness. To be satisfactory, however, this method must employ reflectors of highest efficiency, correctly disposed over the glass to give an effect of uniform ceiling brightness. Liberal space should always be provided between the outer skylight and sub-skylight for the proper mountings of the lamp and reflector elements. Furthermore, generous space for easy access to the equipment for its maintenance should be planned.

It is of great importance to select for the glass of the sub-skylight a material which will have good diffusing quality, one which will obscure a view of the mechanical equipment above and still have a high factor of transmission; that is, one that will allow the greatest possible percentage of the light falling upon it to pass through into the room below. The decorative character of the glass must also be taken into consideration, since from the standpoint of design the main banking room is essentially an artistic type of interior.

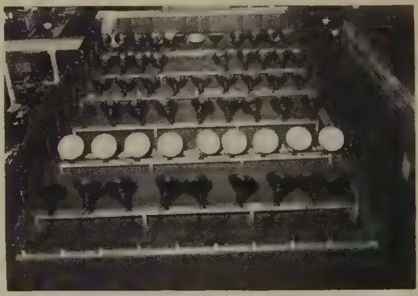


FIGURE 87—General lighting equipment of the Eutaw Savings Bank as placed on top of vault. See Figure 86.

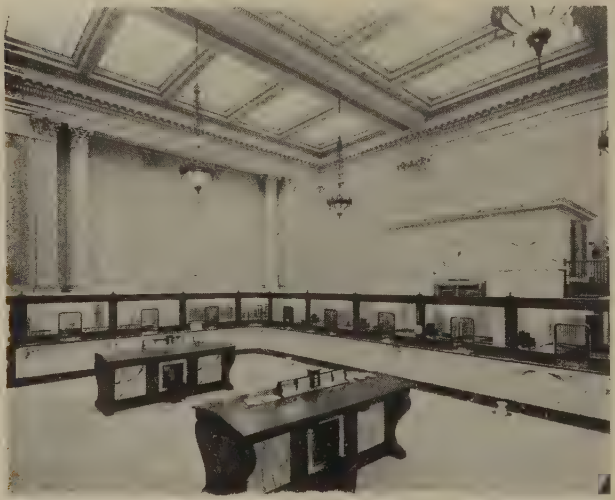


FIGURE 88—The New England National Bank, Kansas City, Missouri. Wight & Wight, Architects. Reflectors above skylight for general lighting, pendant luminaires add an artistic touch.

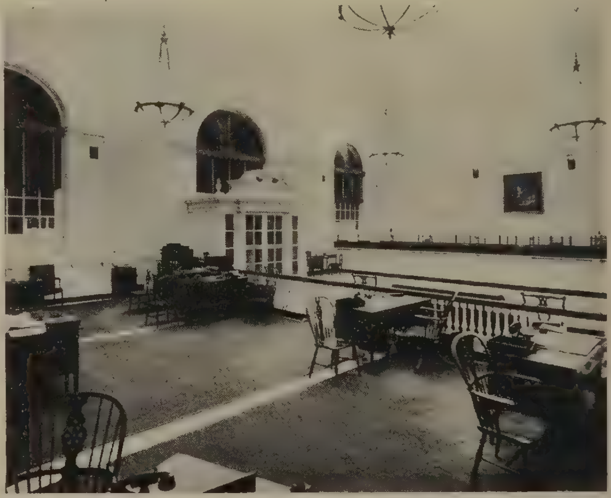


FIGURE 89—Provident Trust Company, Philadelphia, Pa. Rankin & Kellogg, Architects. This beautiful colonial interior appropriately lighted by indirect luminaire of special design.

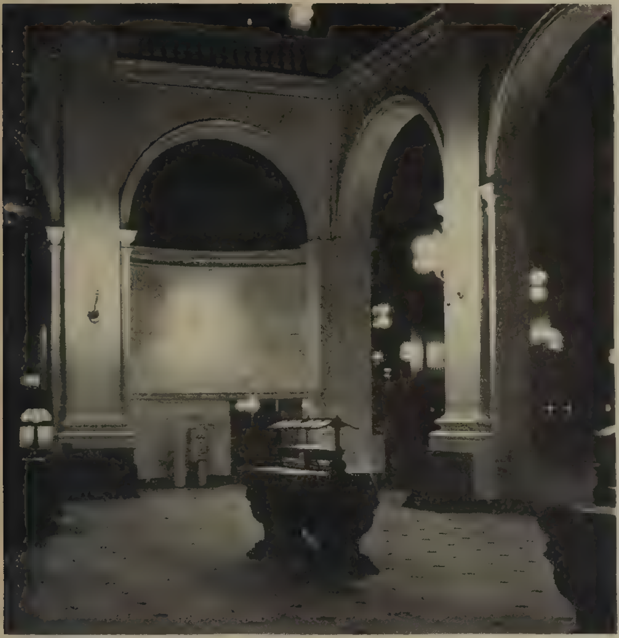


FIGURE 90—First National Bank, Chicago. With old lighting system having as its principal characteristic gloom and glare. Note contrasting results of modernizing as shown in Figure 92.

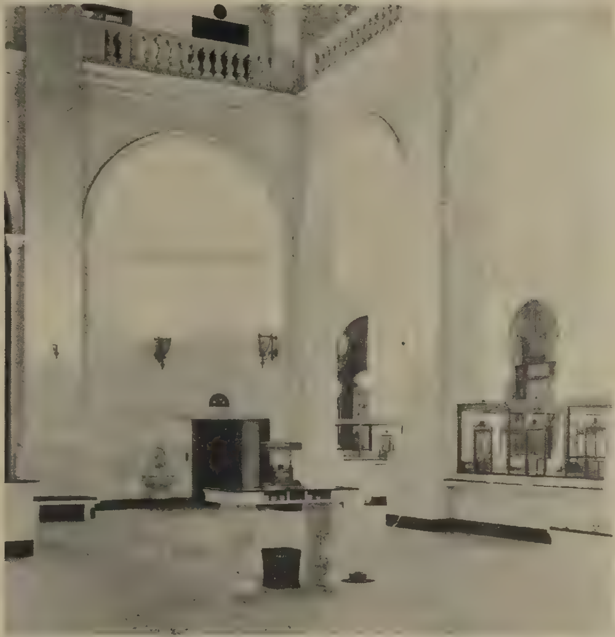


FIGURE 92—First National Bank, Chicago. Leonard Construction Company, Architects. Bronze column brackets containing X-Ray reflectors furnish general indirect illumination.

A novel and interesting example of lighting is to be found in the bank illustrated in Fig. 93. It will be noted that the ceiling is left clear and unobstructed, and that it is suffused with light reflected from units placed in ledges on two sides of the room at a height of 8 or 9 feet from the floor.

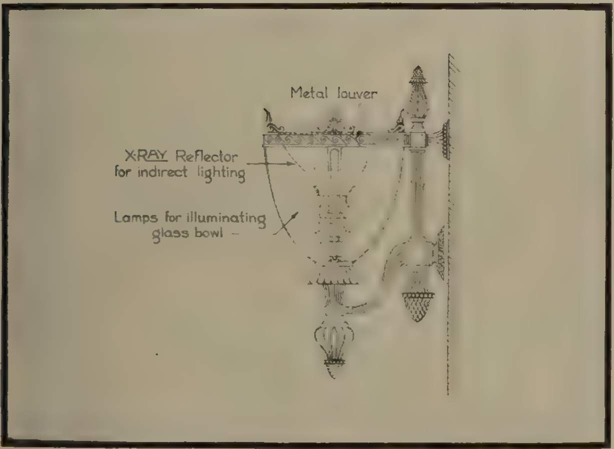

Metal louver
X-RAY Reflector for indirect lighting
Lamps for illuminating glass bowl

FIGURE 91—A sketch of special lighting bracket used in the public space of the First National Bank, Chicago.

The only supplementary lighting in the room is that provided over check desks along the walls and for the tellers' compartments.

A striking example of the changes that may be wrought by the installation of adequate and proper lighting is shown in Figs. 90 and 92, illustrations of a large city bank. The effect of modernizing the lighting is recognized at a glance. One can appreciate the added physical comfort and freedom that the new system provides for both patrons and bank employes, and it is easy to understand how business can be transacted with greater facility, accuracy, without eye fatigue.

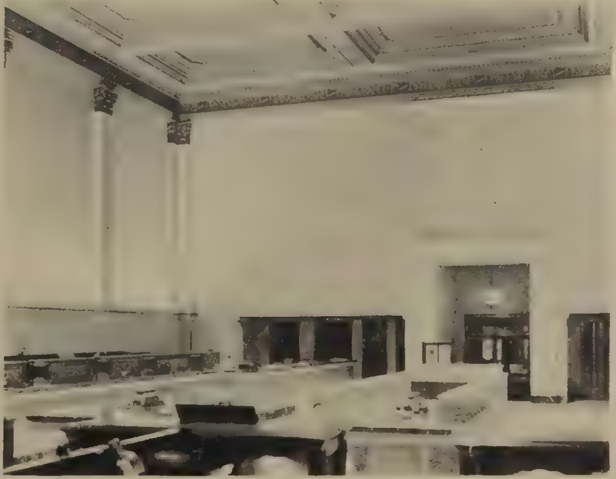


FIGURE 93—National Exchange Bank, Milwaukee, Wis. Van Ryne & De Gelleke, Architects. Illustrating a unique method of lighting from door height ledge where reflectors are recessed.

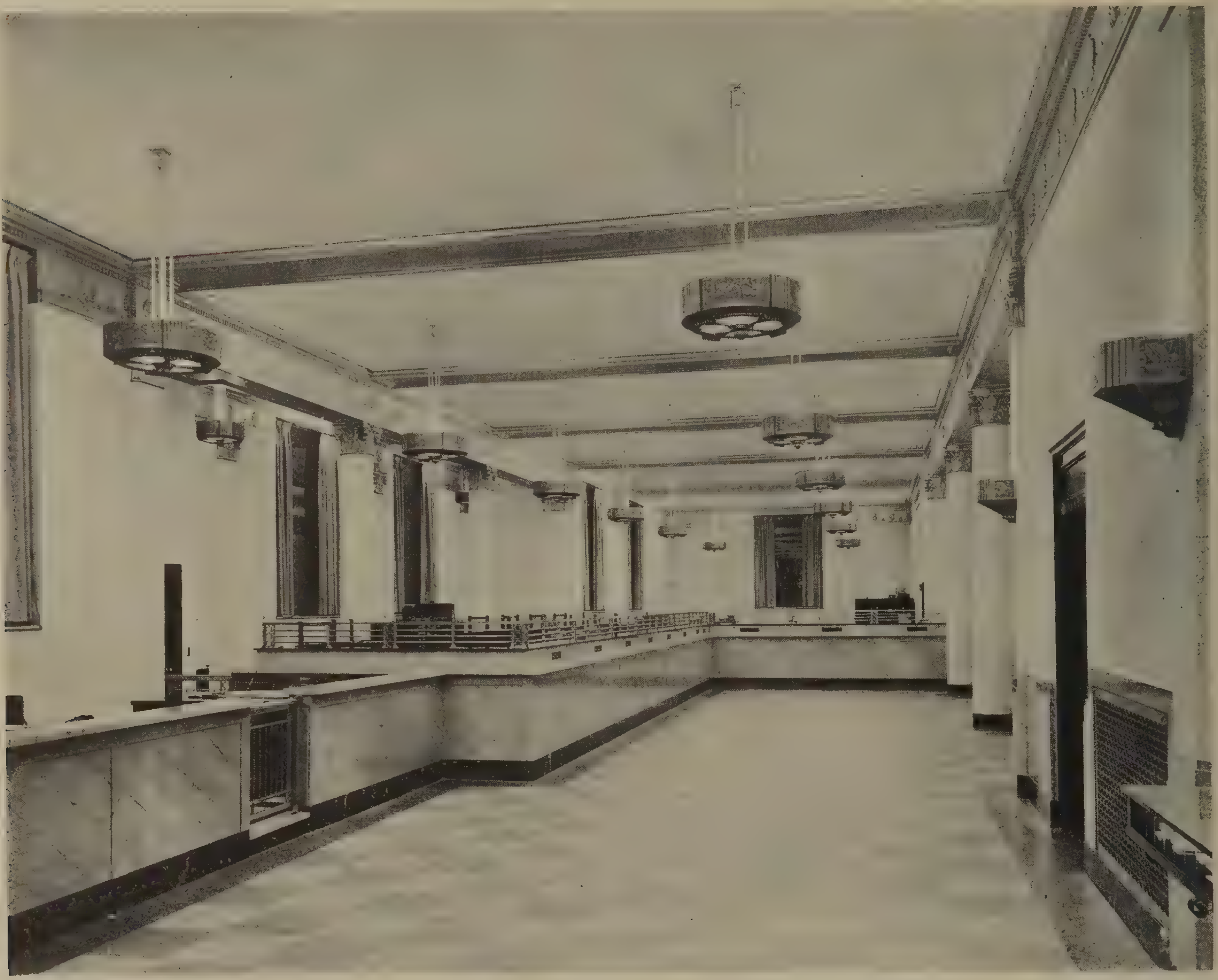


FIGURE 94—State Trust Bank, North Tonawanda, N. Y. Edward B. Green & Son and Albert Hart Hopkins, Buffalo, N. Y., Architects. The present luminaires are designed on modern lines with harmonious column brackets.

The modern trend in lighting and design may be carried out in existing interiors, such as was done in the State Bank Building at North Tonawanda, New York, a photographic reproduction of which is presented in Fig. 94. This room, which has been relighted, has a suggestion of classical ornament in the wall frieze and the capitals of the columns. It was desired to introduce something in the way of a lighting fixture that would be harmonious and yet have an intimation of present-day influences in design. The luminaire illustrated is the one selected because it met with this requirement. The form of the luminaire is classical in feeling while the ornamentation is modern in character, and in harmony with the design adopted for the banking counter. The plain lines of the latter are reflected in the fixture, which with its conventional leaf and flower design "fits in" very harmoniously with the entire

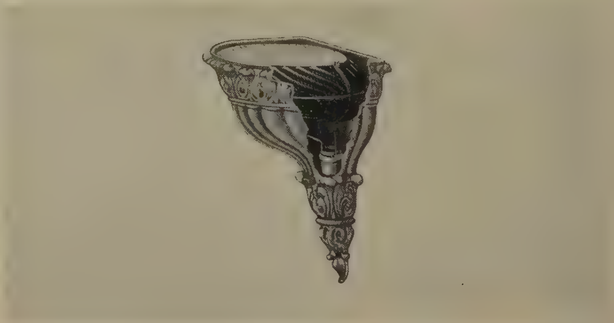


FIGURE 95—Cutaway view of typical composition wall urn for indirect lighting, showing X-Ray reflector of special design.

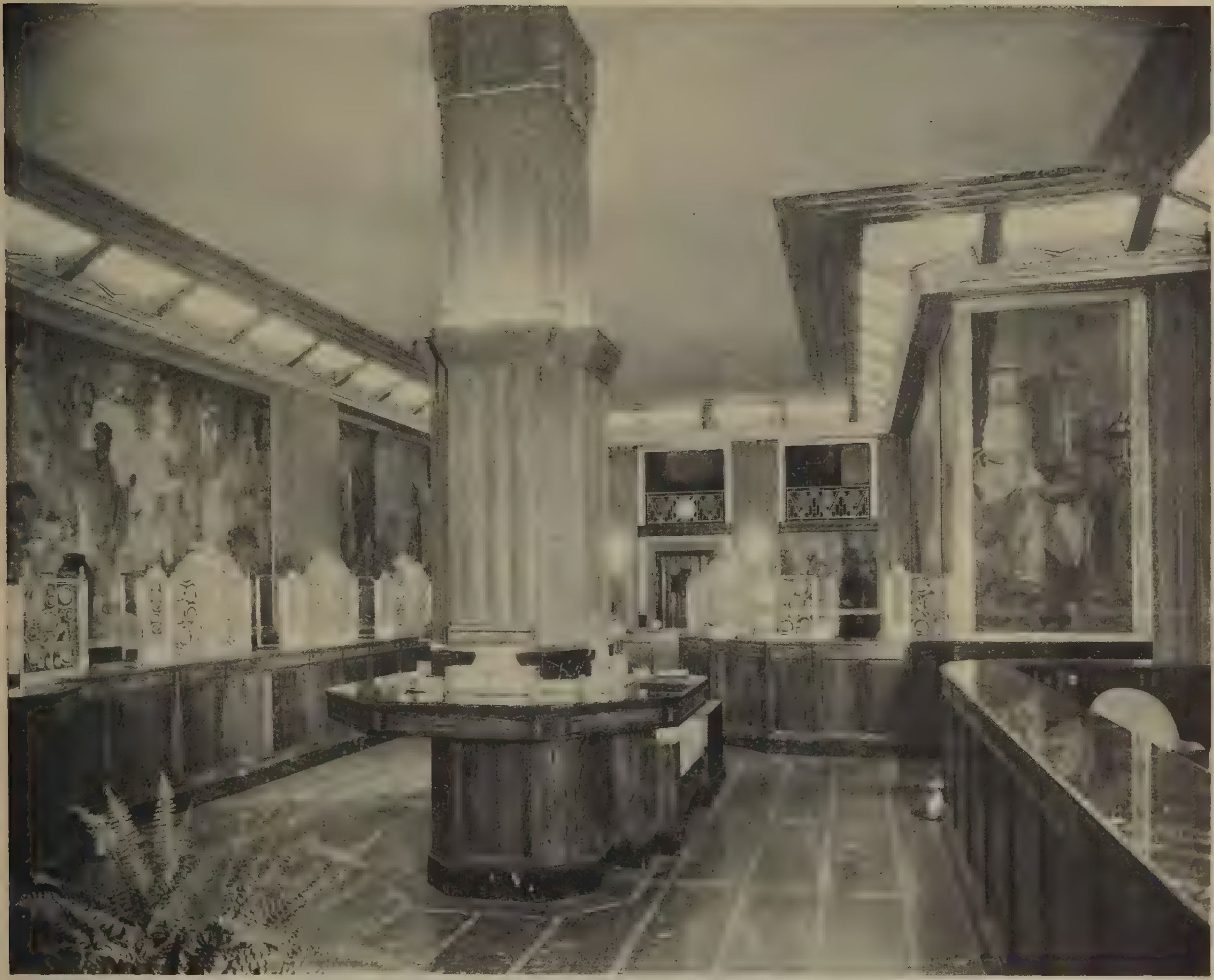


FIGURE 96—Guaranty Building and Loan Assn., Los Angeles, Cal. Feil & Paradise, interior designers. A unique modern lighting method is illustrated. See also Figure 76.

scheme adopted for the interior. This luminaire is of the indirect type, containing reflectors of silvered glass. Supplementary lamps furnish the illumination for the glass panels in the bottom of the fixture, giving a warmth that is very desirable in banking rooms. The finish of the luminaire is in light tones to conform to the general decorative design and treatment.

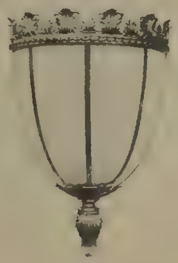


FIGURE 97—Front view of luminous column or wall fitting for indirect illumination in banks and other public interiors.

There are many interesting opportunities in the revealing of works of art, paintings, symbols, etc., which adorn many of our banking institutions. An example of interest is to be found in illustration No. 96. In this bank the walls of the main banking room are covered by paintings of a highly decorative nature. In endeavoring to provide general lighting and also some means of revealing the beauties of the murals, a rather unique scheme of illumination was adopted. The modern lighting application here made is identi-

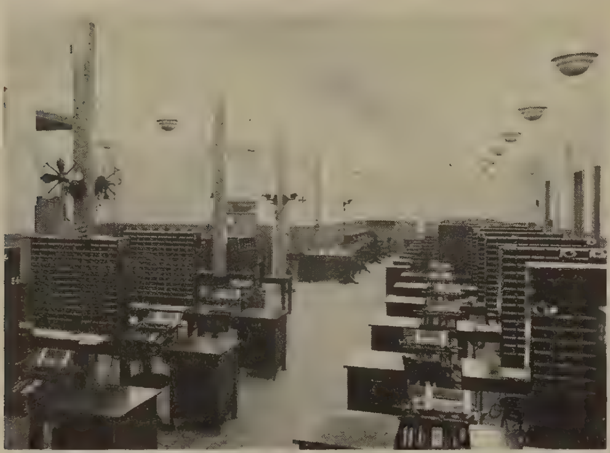


FIGURE 98—Statistical Department, Federal Reserve Bank, Chicago, Ill.

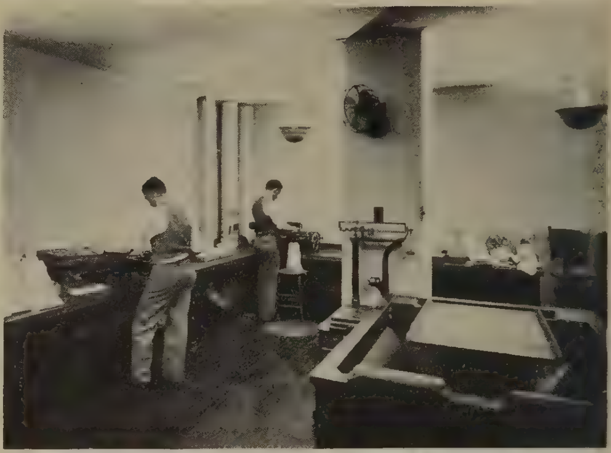


FIGURE 101—Coin Room in Federal Reserve Bank, Detroit, Michigan.

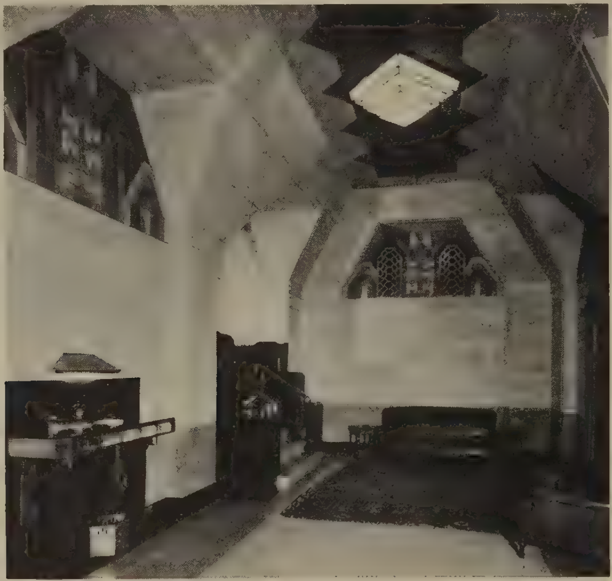


FIGURE 99—Entrance to safe deposit vaults, Union Trust Company, Detroit, Michigan.

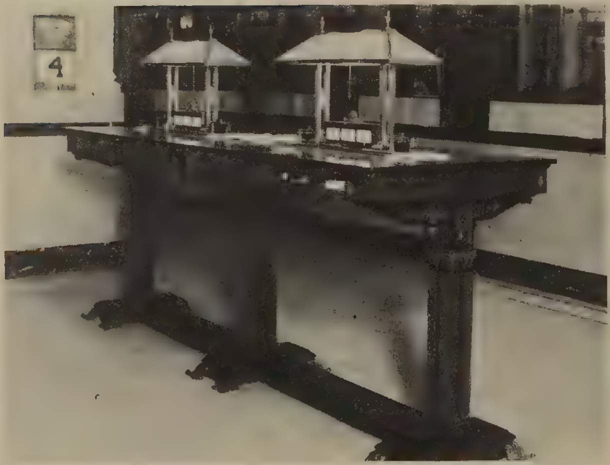


FIGURE 100—Check desk lights in Railway Brotherhood Bank, Cincinnati, Ohio.

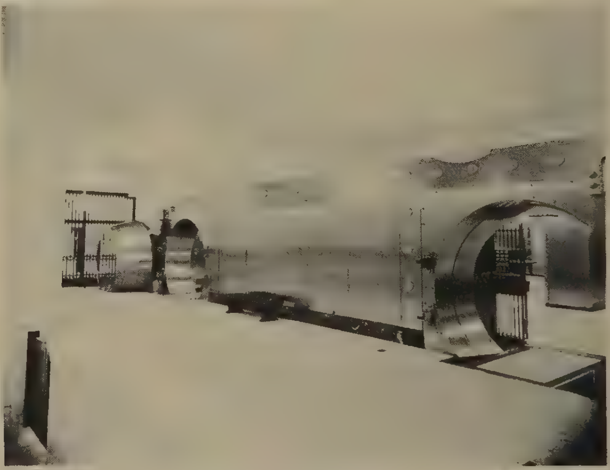


FIGURE 102—Vault, First National Bank, Chicago. Appropriate lighting suggests security.

cal with that of the conference room of the same institution, which has been described and illustrated on page 76. The recessed cove lighting is supplemented by unobtrusive column units containing lamps and reflectors which assist, for the center of the area, in producing the proper intensity of illumination.

Lighting of Miscellaneous Departments

The lighting methods to be recommended for the miscellaneous departments of the bank depend entirely upon the physical conditions to be encountered and the type of work carried on in the particular space. The following departments should have particularly careful attention when the lighting plans are made: the directors' room, tellers' cages, vaults, book storage rooms, safety deposit department, bookkeeping, coin rooms, traffic and mailing departments.

For the working areas a general illumination is, in practically all cases, satisfactory. However, for the tellers' cages special lighting is usually provided to aid the teller in performing his operations accurately and to assist him in detecting fraud. The officers' space usually is out in the open area of the banking room, adjacent to the main entrance, or in the center of the public space. The general lighting usually suffices for the officers' quarters also.

For office spaces in the bank the rules set down for general commercial office lighting apply. Reference should be made to page 69. Such working spaces as the statistical department require careful planning. Here very accurate, rapid work is required on cards containing records from which statements and reports are made. Fig. 98 shows a room of this character, in which speed and accuracy are facilitated by favorable lighting.

The substantial character of the banking institution is no better illustrated than in the vault space. The huge vault doors are designed for security. Harmonious lighting is required, not only for the best visibility, but also to assist in obtaining the proper atmosphere in this department.

The example in Fig. 99 illustrates the entrance to the great security vaults in the first basement of a large city bank, where a ceiling luminaire of square panel design supplies the general illumination, with suplementary lighting by shaded wall units above the check desk. The finish of the luminaire is in harmony with that of the other metal work throughout the building — Monel metal chased in alternately polished and dull surfaces.

Excellent lighting is required for such working spaces in the bank as the currency room and coin room. Frequently in the currency room, where thousands of bills are counted and checked, a daylight correction for the lighting is desired to facilitate the detection of flaws and counterfeiting. The commercial system of indirect illumination equipped with blue daylight lamps has been found to be particularly satisfactory for currency room lighting. Illustration No. 101 shows the practical application of the indirect system to a coin room, where a large number of coins are counted by special machines, and where a well diffused light of good intensity is required.

Illuminated direction signs are of great assistance to the patron of the bank in finding departments in which he is interested. These illuminated signs are of standardized types and makes, sometimes, however, requiring special designs to conform with the style of architecture or treatment of the bank interior.

In cases where they are required or desired, check desk lights are employed. A typical example of check desk equipment is shown in Fig. 100, and, as will be noted from the illustration, combined with the light is a calendar and waste paper box. Since it is important to protect the eyes of the patrons from the glare of exposed lamps, the check desk lamp is usually of low type, designed for shading and diffusion.

All banks contain many miscellaneous departments and locations where a light can be used advantageously. For example, many institutions are installing what is known as a night depository— a mail box type of opening on the exterior of the bank, in which deposits may be made by custom-

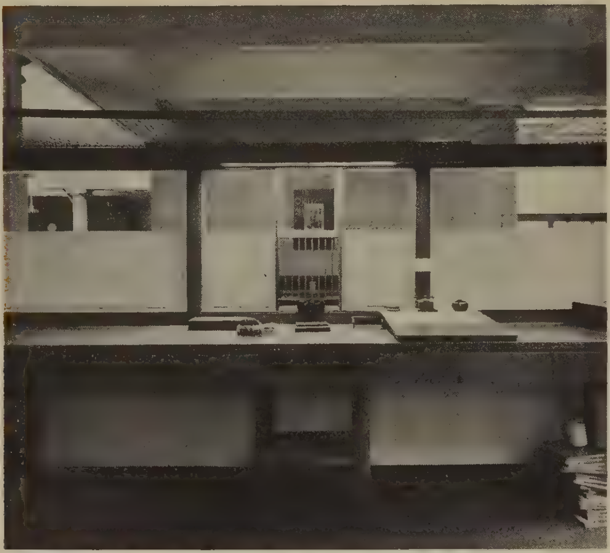


FIGURE 103—Typical view in teller's cage where good working light will aid in detection of fraud and counterfeit and facilitate the serving of patrons.

ers after the regular banking hours. The depository is easily arranged so that upon opening the slot a light is automatically turned on, illuminating a tray into which the deposits are made.

Many banking rooms have in their architectural treatment relief or carved figures, symbolic of industry and security, such as the wise owl, the busy bee, the nut-gathering squirrel, cog wheels, conventional treasure chests, or scrolls of accounts. Much time and thought have been devoted to these beautiful symbolic carvings, and in many cases they are entirely unappreciated by the public because of the fact that they are not properly illuminated or brought out in contrast to their surroundings. The illuminating engineer can frequently make suggestions in planning bank lighting to improve the emphasizing of these symbols, which recall the rich traditions and interesting historical background of the banking institution.

The amount of light to be used for the different departments of the bank varies somewhat as given by different authorities. It is generally agreed, however, that the lobby or general public space should be provided with an intensity of about 6 to 10 foot-candles. The tellers' cages require a greater value because of the speed and accuracy required, an intensity of 10 to 20 foot-candles is suggested. For space where clerical and general office work is done, standards are recommended as used for office lighting in commercial institutions, namely, 15 foot-candles for close work in general offices, 10 foot-candles for private office spaces, vaults 5 foot-candles, reception rooms, 5 foot-candles, filing room 5 foot-candles.

Tellers' Cages

Diffused illumination for the tellers' cages, in which a high intensity of light is needed to insure speed and accuracy, is provided in the most satisfactory manner by equipment as shown in Fig. 104. This scheme consists of a special housing constructed of heavy gauge steel or bronze, with front and back mouldings of plain or ornamental character. Contained within the housing are lamps and reflectors designed to direct the light downward through a diffusing glass upon the counter of the teller's cage. The particular type

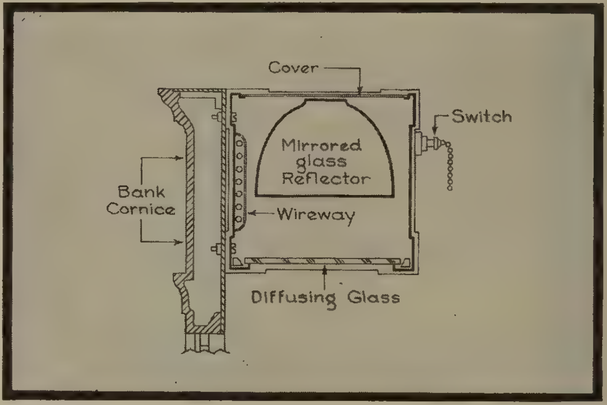


FIGURE 104—Diagrammatic section of "Bank-Ray" equipment designed especially for the direct illumination of the teller's deal plate and counter.

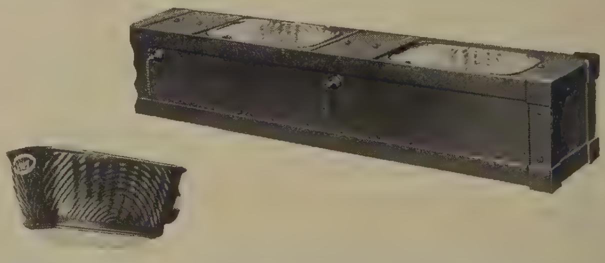


FIGURE 105—An indirect lighting equipment for attaching to the banking screen to provide illumination such as illustrated in Figure 80.

of equipment is of standardized construction, and can be attached in a simple manner to any of the usual types of bank cage cornice. For the lighting over the deal plate usually two 25 or 40-watt lamps are sufficient.

In many banks a combination of upward lighting for the public space and downward lighting for the bank cage counter is desirable. This has been worked out in a practical way with equipment such as illustrated in Fig. 105. Usually for the upward lighting, or the indirect illumination of the general space, reflectors are provided, with capacities for 150-watt lamps spaced at desired intervals throughout the entire length of the housing. Provision is made for the switching of lights for individual cages, and the circuiting may be arranged so that the control of the direct lighting over the cage counter is independent of the equipment that produces the general illumination for public space. Frequently it is desirable to illuminate signs designating the number of the cage or its character, and reflectors and lamps may be placed in the metal housing to accomplish this, or a separate small lighting unit is employed and installed independent of the general lighting equipment for the room.

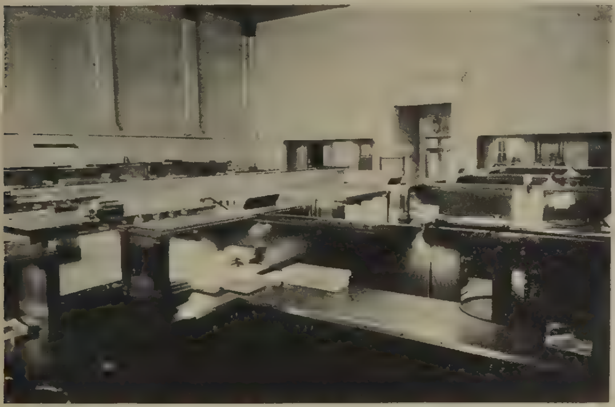


FIGURE 106—National Exchange Bank, Milwaukee, Wis. Van Ryne & De Gelleke, Architects. Note special compartments for tellers and the lighting method employed.

The architectural construction of the banking screen of the present day is much more simple than it was a few years ago. In fact, a decided change has been made in the past three or four years in favor of discarding the high banking screen for a type of low counter.

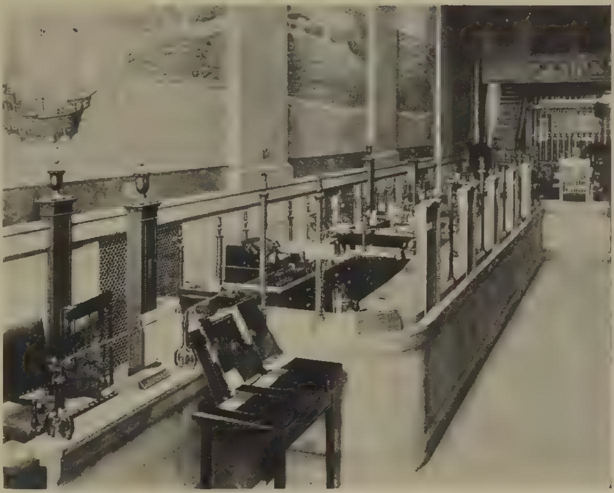


FIGURE 107—Bank & Trust Company, Atlantic City, N. J., H. A. Stout, Architect. Illustrating a style of banking screen without cornice and which is gaining in popularity. This type necessitates local bracket lights for the cage counter and deal plates.

The low type of screen introduces a new problem in illumination of tellers' counter and the deal plate. Various schemes are being employed. Typical examples shown in Figs. 106 and 107 illustrate two distinct types of low counter screen. The illumination in example Fig. 107 is accomplished by means of small individual lamps of a bracket type, attached to the counter screen, one over the center of the deal plate and one at each side of the wicket. The unit is of such design as to shade the eyes of the teller and also of the patron, but still casting a strong illumination upon the deal plate and the teller's work table. The bracket unit above the center of the deal plate also serves to illuminate the wicket sign which gives the designation or number of the particular cage.

A radically different type of banking screen is employed in example shown in Fig. 106. In fact, the banking screen is practically absent, and for it is substituted a rail, which at the deal plate returns to form a box or compartment in which the teller keeps paper and currency. The open friendly character of the room with a construction of this type is very apparent, and gives a strong contrast to the type of bank interior that was common only a few years ago.

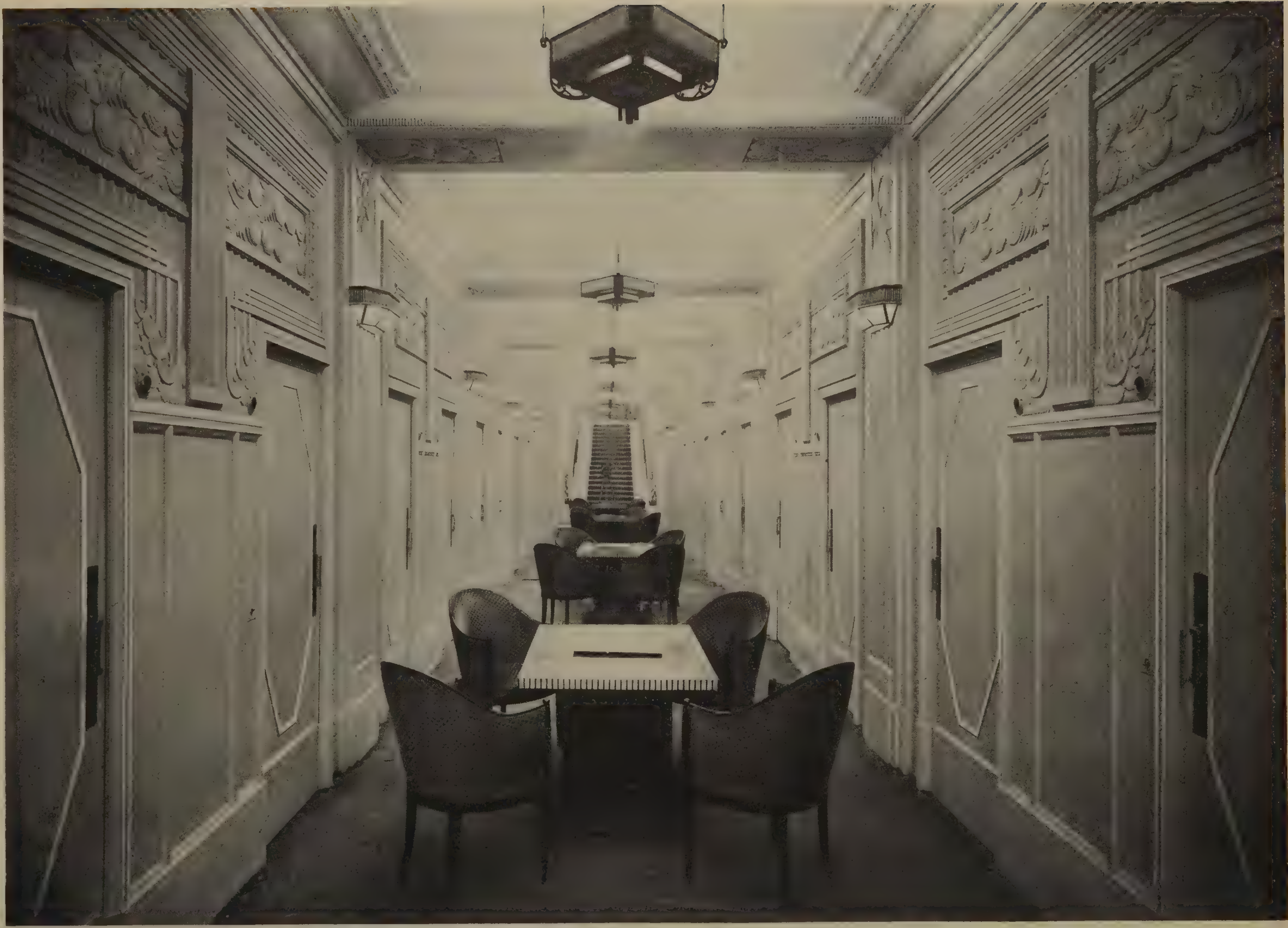


FIGURE 108 Fitting room passage, establishment of Alba, Paris, France. To harmonize with the interior, which is entirely in modern art design, the indirect ceiling and column luminaires containing X-Ray reflectors have been especially designed and installed by Compagnie des Lampes.

STORE LIGHTING

EVERY merchant has faith in the potency of light. He knows that good lighting produces an inviting atmosphere, that it is the only means of properly revealing the merchandise in its true value and color. He knows that good lighting in a store is a mark of progressiveness. He realizes that it has advertising value, bringing his particular establishment into a different class. He knows that light can be a definite sales help, that it will put the customer at ease, and provide an atmosphere in which the sales people may work with comfort. He has found that good lighting will aid in the selection of goods, prevent mistakes in a large degree, and, therefore, simplify the problem of returned goods.

Light is often considered as the unseen salesman. He may be a good salesman or one of the indifferent type. He may enable the owner to make additional sales, or may send customers away with an unfavorable impression. It is frequently interesting to consider the lighting of a store as being a real personality. It is helpful in determining the proper idea of its influence and for the purpose of analysis. The ability of the lighting system to produce sales has been measured, and a progressive merchant knows whether or not his silent salesman produces efficient results.

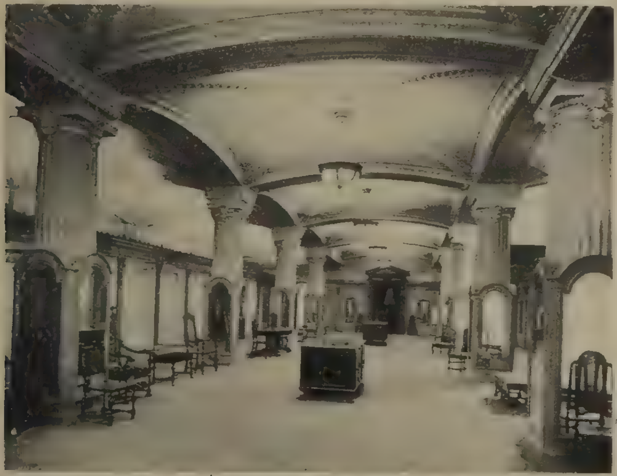


FIGURE 109—Russek's, ladies' furnishings, New York City. Frank Severance, Architect. Supplementing the general illumination from indirect fixtures are X-Ray reflectors placed on the tops of the fitting booths at the sides of the room.

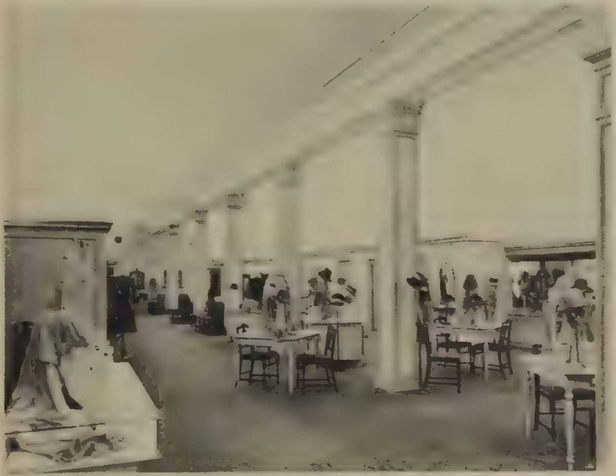


FIGURE 110—Smartwear Shop, Milwaukee, Wis. All lighting equipment is entirely concealed from view. Advantage has been taken of the general layout of the cases and the architectural features for the placing of reflectors and lamps.

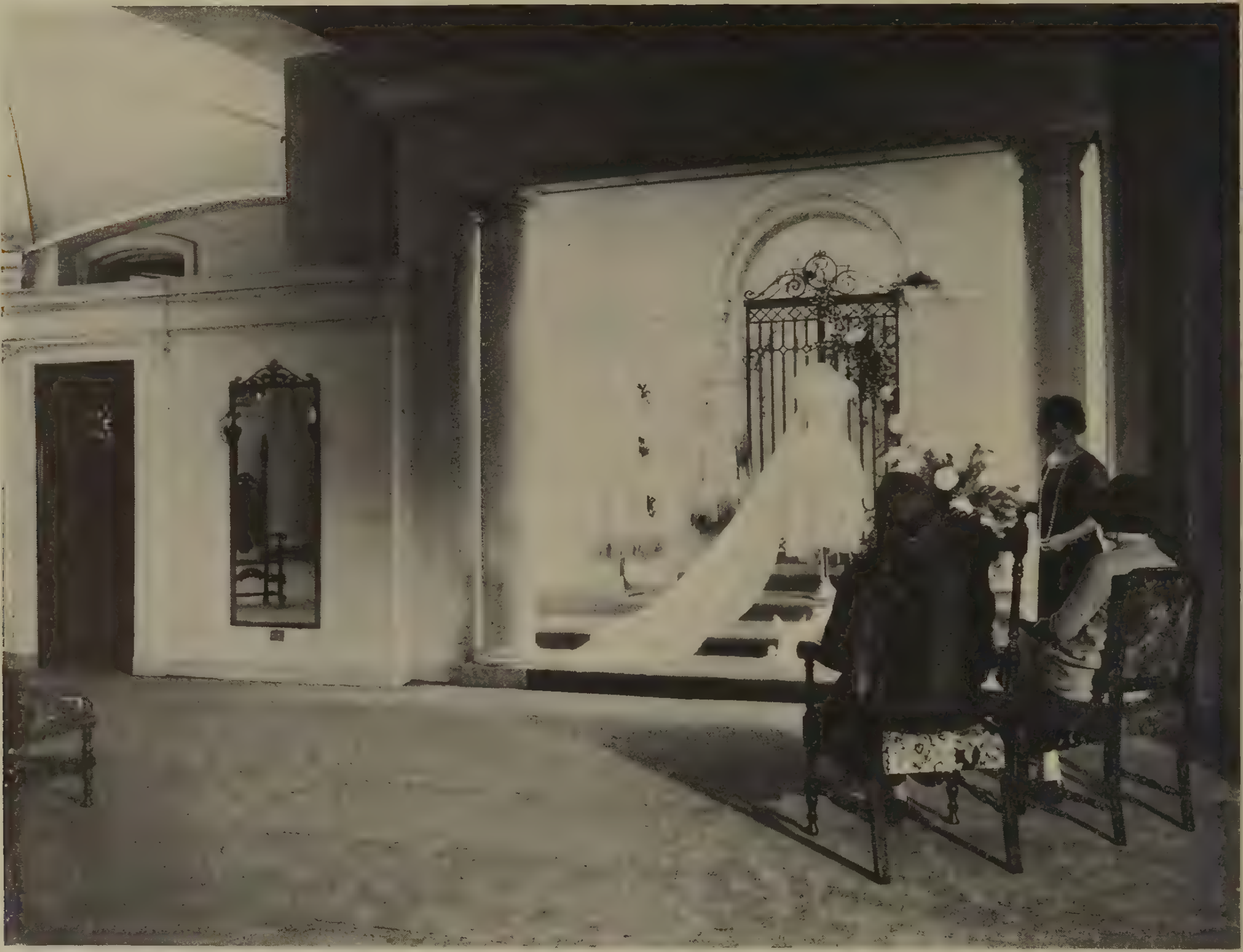


FIGURE 111—Russek's store, New York City, Frank Severance, Architect. This display alcove has been treated like a stage, with a series of overhead lights hidden back of the beam. Strip lights at the sides of the space are used to obtain flexibility and special lighting effects from modeling.

Competition is demanding that stores raise their standards of lighting. As new stores come into existence with artistic, high intensity lighting systems, the older established stores must make changes in the lighting if they expect to compete successfully. Many merchants are yet unaware of the value in dollars and cents that such changes, with compartively small outlay of money, will return to them.

Ladies' Apparel Shops

For shops offering ladies' furnishings, the indirect lighting system has been found to be extremely appropriate and satisfactory. Several specific cases are given to illustrate methods of application. In Fig. 108, for example, we see the

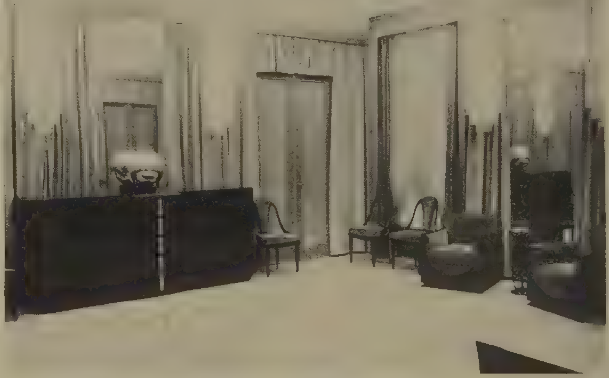


FIGURE 112—Salon de Coulture Pauline, Paris, France. A salesroom in the modern vogue, with unique equipment for indirect and direct lighting at appropriate intervals on the wall area, planned by Compagnie des Lampes.

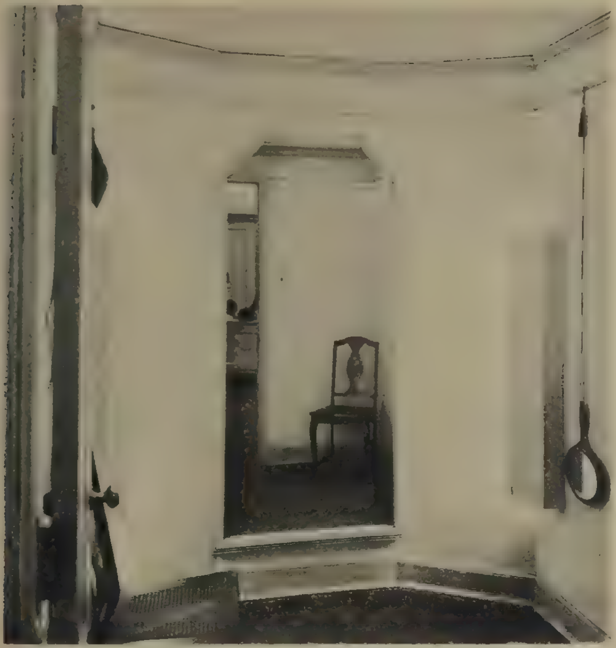


FIGURE 113—Fitting room of the Smartwear Shop, Milwaukee, Wis. The lighting equipment is concealed in the housings on the wall at each side of the mirror.

fitting room corridor of the Alba establishment in Paris, designed in the Art Moderne, with luminaires in harmony.

There is an element of surprise in the reaction that one obtains in walking into a store illuminated in the manner of the Smartwear Shop, Milwaukee, as shown in Fig. 110. The treatment adopted here emphasizes the fact that lighting should be unobtrusive. The entire absence of ceiling fixtures is apparent as one enters this room. In fact, the usual pendant fixtures would be more or less out of place after having once seen the room with the present method of lighting, with all reflectors and lamps concealed entirely from view on the tops of the cases near the side wall. The illumination is so evenly distributed, so diffuse, and so like daylight in its general aspect, that it furnishes a particularly ideal condition under which to select items of merchandise.

As an illustration of how light may be used to give emphasis, the setting of Fig. 111 is included. Here a stage-like display booth has been constructed in Russek's store, New York, by the architect, Frank Severance, and is employed with great effectiveness in the sale of gowns. The attention of the customer is not distracted. The method of lighting is similar to that in the show window, with X-Ray reflectors concealed from view behind the beam supported by the columns.

As an aid to sales, many of the best establishments provide special alcoves or departments for the trying on and fitting of garments. The best lighting facilities are necessary for these spaces. Various schemes have been employed to get the best effect. In Fig. 113, for example, a special system uses a lighting strip on the two sides of the mirror, with small X-Ray reflectors mounted inside a sheet metal housing concealing them from view. The light is directed over the side wall surface, and in turn reflected back into the fitting room and on the model or figure.

An entirely different system is employed for the room illustrated in Fig. 114. Here totally indirect lighting is installed in the cove of an ornamental cornice. A remarkably well diffused illumination pervades the entire room, and the system is particularly ideal because of the number of mirrors that are employed. In a large room of this kind, general lighting of daylight quality is more desirable than a form of localized lighting, such as used in the previous example.

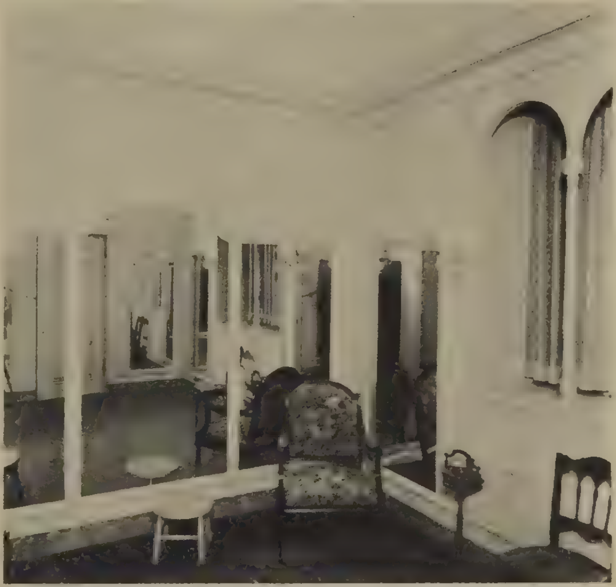


FIGURE 114—Fitting room of Myer & Sieger, Los Angeles, Calif. The designers were Feil & Paradise. A scheme of cove lighting was found to be most appropriate and satisfactory for this elaborate fitting room.

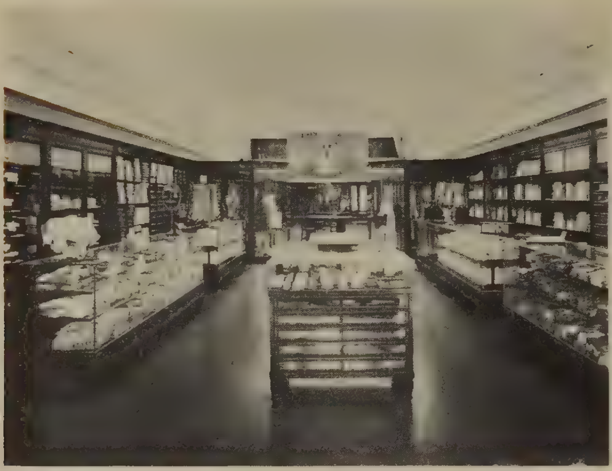


FIGURE 115—Grosner's store, Washington, D. C. Victor Mindeleff, Architect. Above the wall cases in a special compartment X-Ray reflectors are concealed and produce a flood of diffused illumination especially appropriate for a men's furnishings salesroom.

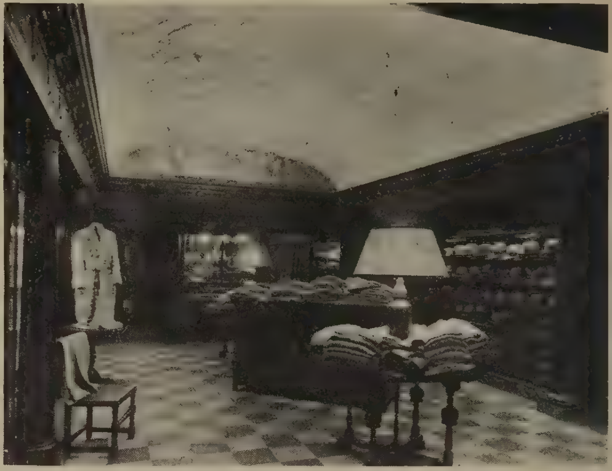


FIGURE 116—Finchley's Men's Store, New York, N. Y. Beverly King, Architect. The entire store is lighted by lamps equipped with the Curtis indirect adapter mounted on pottery bases, with parchment shades. A distinctive method for a merchandising establishment.

Men's Furnishings Shops

The Grosner establishment for men's furnishings, in Washington, D. C., is one of the smartest shops of the Capitol City, and has utilized light in making the store attractive. The main floor salesroom has a method of concealed or hidden lighting, with equipment installed on the tops of the wall cases. The arched ceiling is perfectly illuminated, and the room lighting is of such a character that one is unaware of any change in quality when coming from the daylight. The windows of the second floor have been utilized as a striking advertising feature. At night they are covered with a full length drape, at the base of which X-Ray reflectors with color accessories are utilized to produce very attractive color variations. The store is opposite the largest theatre in Washington, and is the subject of comment by thousands of persons nightly. Mr. Grosner has realized the value of high intensity lighting and has equipment that gives about 18 foot-candles of illumination throughout the establishment.

Mr. Beverly King, when he designed the Finchley stores in Chicago and New York, set out to devise something unique in the way of a men's shop. The entire space is divided into individual rooms, each being devoted to a particular kind of merchandise. For example, there is a shirt room, a necktie room, a leather goods room, a hat room, etc., in fact, a gallery of small shops, each of which is treated individually from the decorative standpoint. In searching for the proper means of lighting these various divisions of the store, Mr. King desired something of individual character,

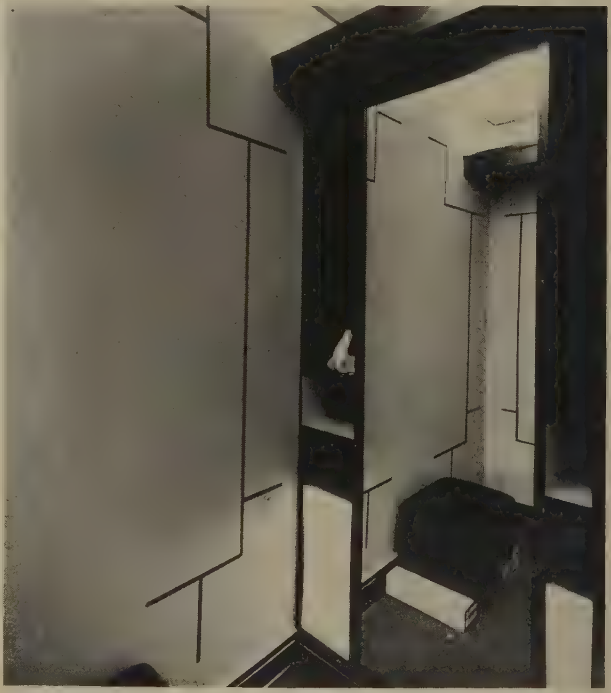


FIGURE 117—Schulein's, Inc., shoe store, Spokane, Wash. Rigg & Van Tyne, Architects. An alcove fitting room in modern design and with special lighting effects.

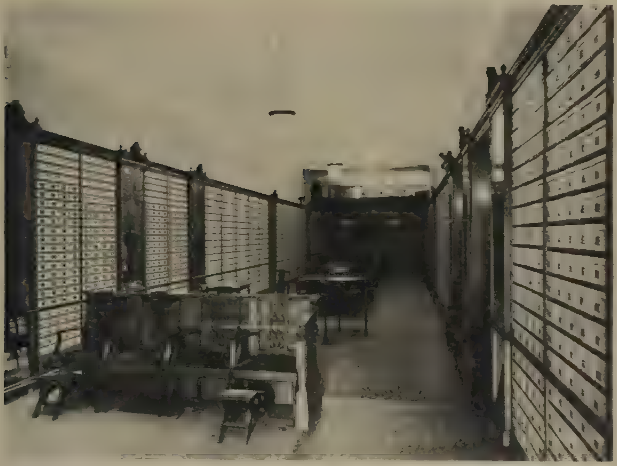


FIGURE 118—Morton & Morton Shoe Store. New York. N. Y. Lighting that definitely assists merchandising, comfortable for the shopper and helpful to the salesperson.

yet thoroughly rational, and decided ultimately to use the Curtis indirect portable lamp throughout, thus providing the artistic touch that was necessary and a lighting of quality at the same time. The establishment, which is world-famous, has a large range of fabrics and colors that are a test for any lighting system.

The Curtis indirect portable lamp, which is further described on pages 201 and 287, has a large pottery base and is equipped with a decorated parchment shade. Each lamp utilizes a 300-watt or 500-watt lamp. The managers under no conditions would discard the indirect lamps and install in their stead a variety of the usual type of fixtures, so enthusiastic are they about this novel and artistic system.

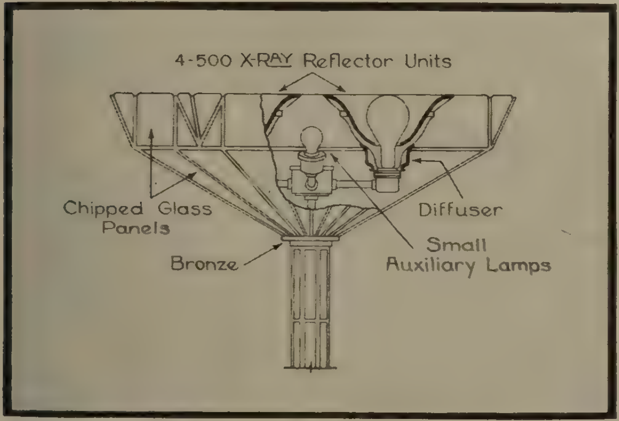


FIGURE 119—Detail of the light pedestal used in the Ward shoe store illustrated in Figure 120.

Shoe Stores

In considering the lighting for a shoe store, such as illustrated in Fig. 118, we might well compare its requirements to those to be met in the book stacks of a library, where it is necessary to be able to read with ease the title of any volume near the floor as well as on the uppermost shelf. The qualities of diffusion peculiar to the indirect system entirely meet with this requirement. It may be noted from the illustration that the details at the lower shelves are just as distinct as those near the ceiling. This beautiful illumination is received from the few simple luminaires suspended from the ceiling.

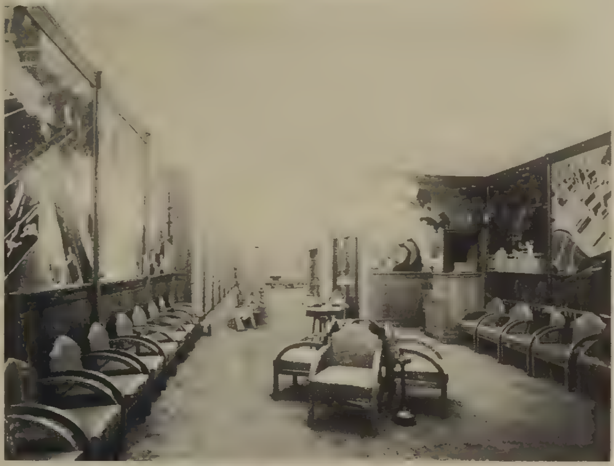


FIGURE 120—John Ward, men's shoes, New York, N. Y. Note the modern touch in the design of all details, including wall decorations, furniture and indirect lighting pedestals.

On Fifth Avenue, in New York, one of the world's smartest business streets, are found many ultra-modern shops and magnificent sales establishments. The shop that attracts the public must be in many ways unusual and distinctive among its neighbors. The people responsible for the store illustrated in Fig. 120 are very progressive merchandisers, and since they were building an establishment on Fifth Avenue for the first time, it was planned to do something that would excite comment, yet avoid any suggestion of the bizarre and stay within the bounds of the established dignity of the organization and the merchandise which it offers to the public. In the Ward shoe store we have an example of how light was used

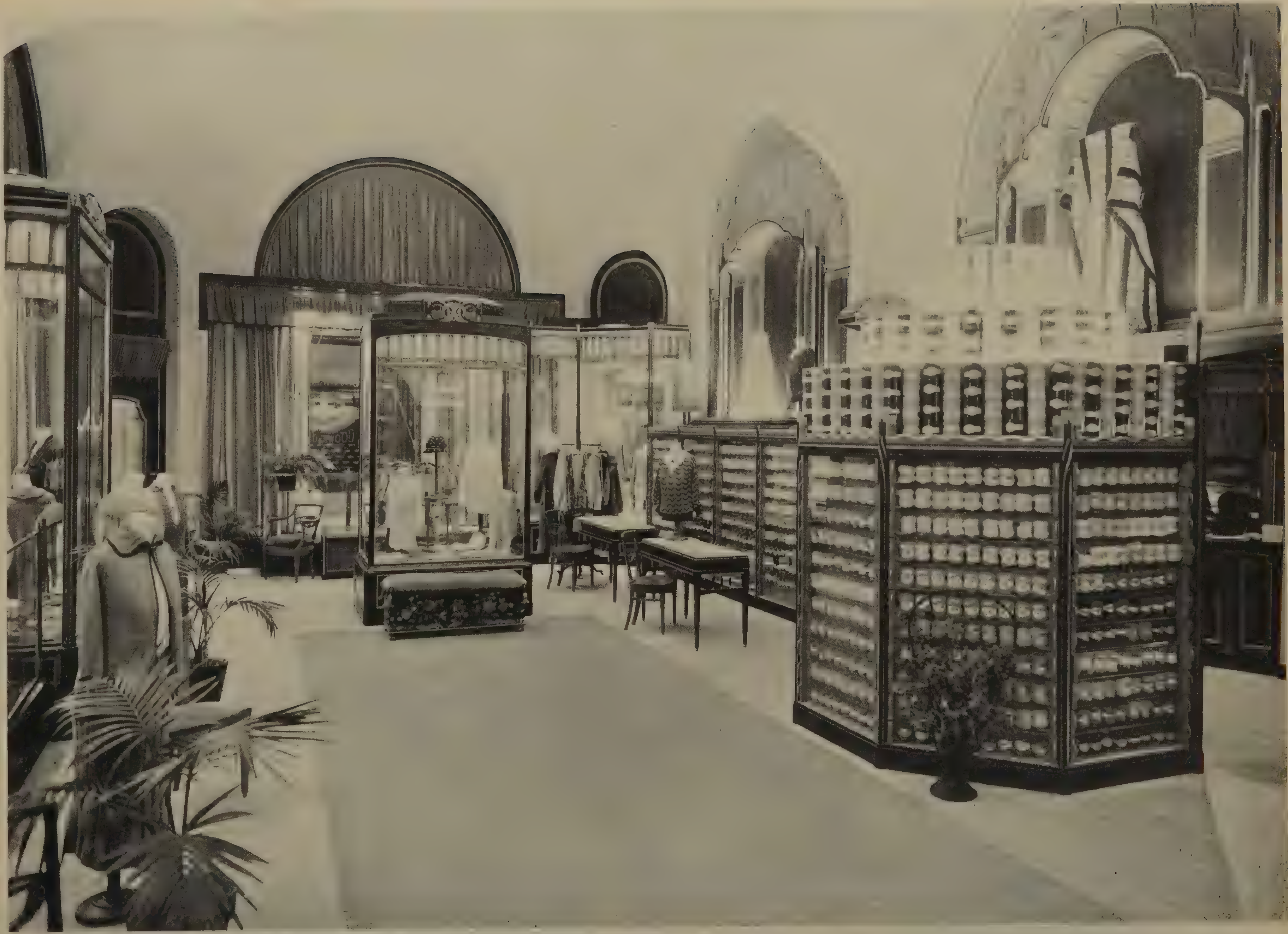


FIGURE 121—*A yarn shop designed by the architectural firm of McLanahan & Benckner, of Philadelphia, Pa. The arrangement of display cases affords an excellent opportunity for the concealment of the illuminating devices. No obtrusive equipment is apparent, and the illumination is in strict harmony with the general aspect.*

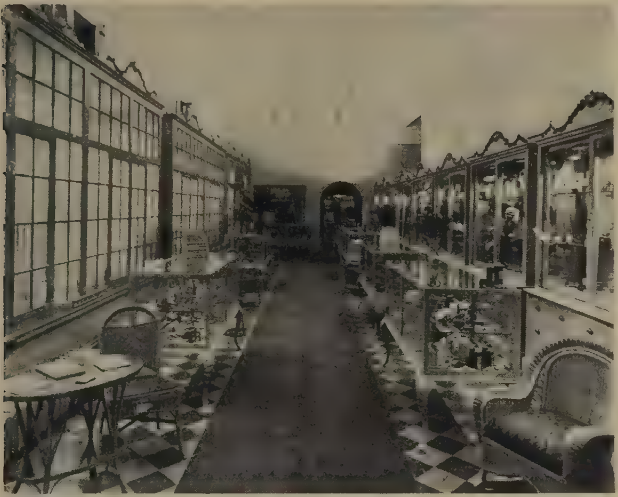


FIGURE 122—Hairdressing establishment. An aristocratic atmosphere produced by concealed lighting from tops of cases.

as a keynote in obtaining, to the fullest extent, extraordinary attractiveness.

The lighting scheme, at once evident from an inspection of the illustration in Fig. 119, consists of floor standards of chipped glass and bronze. Contained within the bowl are three 500-watt X-Ray mirrored reflector units, supplemented by auxiliary sockets for a small amount of direct light through the panel glasses. Each lighting pedestal illuminates an area of approximately 20 square feet. For portions of the space not provided for by the pedestals, ample illumination from cove lighting is provided with units mounted on top of the stock cabinets. These produce an intensity from 8 to 10 foot-candles for the rear of the store. Each mirrored glass cove lighting reflector utilizes two 40-watt lamps. Satisfactory results are obtained with reflectors only 18 inches from the ceiling.

Miscellaneous Shops

Stores fall into natural classifications as regards their lighting requirements. We have the large department store, the smaller shop, or neighborhood store, and the distinctive or highly specialized shop. Fundamentally the lighting requirements are the same; that is, good illumination should be provided with light sources shielded to prevent the introduction of glare, and proper consideration be given to the artistic features. In the highly specialized shop, the artistic becomes a greater factor in the planning than for the department store. Each individual case must be carefully studied, and the discrimination of the customer must be taken into account. Some proprietors are willing to spend considerable sums of money on handsome and lavish furnishings, and think the artistic appearance a predominating factor. A distinctive and unique lighting system, therefore, is one of the best means of making the shop an outstanding one in the community. Efficiency of the utilization of light in a case of this sort is of secondary importance.

Concealed lighting methods have had a very definite and important function in the modern movement in illumination. Very attractive and practical effects are obtained by this means. An especially interesting example is shown in Fig. 121, where lighting has been used to produce a distinctive atmosphere in a yarn shop. The complete elimination of pendant luminaires has been a logical result of the careful study of best methods of illumination for this place where goods are sold. The arrangement of display cases and other architectural furnishings offers excellent opportunities for concealment of the illuminating devices. No obtrusive mechanical equipment is apparent, and the illumination received is of a

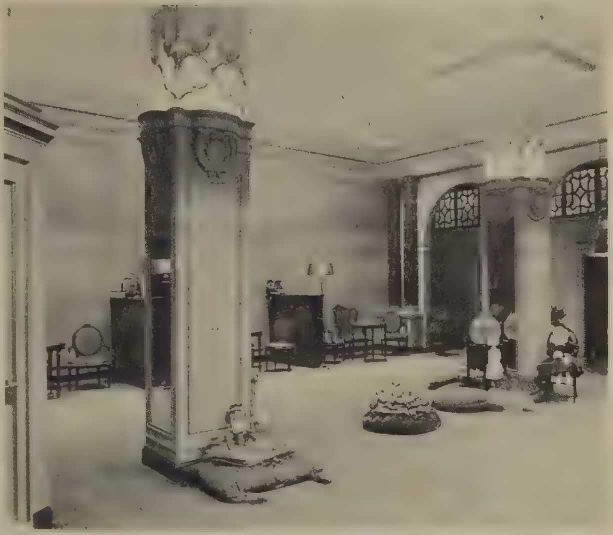


FIGURE 123—Hairdressing shop, having lights in the columns for decorative effect and concentrated illumination upon the tables from units hidden in the ceiling.

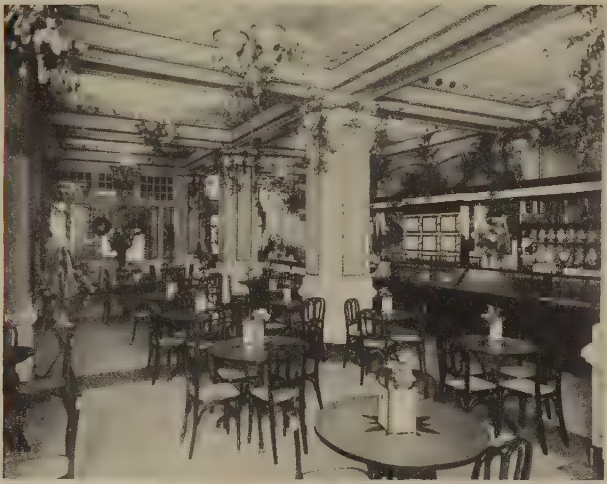


FIGURE 124—Putnam's candy store, Cincinnati, Ohio. Fixtures are of special design and contain X-Ray reflectors for 100-watt lamps.

character in strict harmony with the general aspect of the interior.

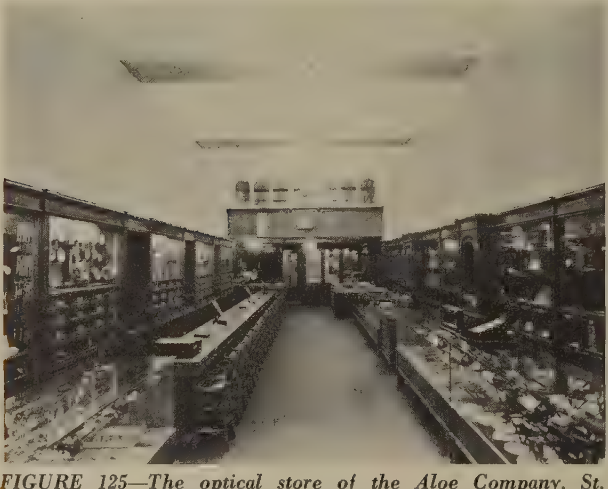


FIGURE 125—The optical store of the Aloe Company, St. Louis, Mo. General indirect illumination, supplemented by localized case lighting, has been found ideal for this important class of business.

Hairdressing establishments offer many opportunities for unusual and practical lighting. In Fig. 122, for example, the general lighting is accomplished in a manner similar to that for the Garden Yarn Shop, with all equipment for indirect illumination hidden from view on the tops of the wall cases and show window enclosures. This equipment takes care of all the illumination requirements, with the exception of the wall cases, which have individual lights of the style illustrated on page 263. Note the exceptional distinctness with which all details are revealed in Illustrations 121 and 122. This would not be possible with a system of illumination lacking the important quality of perfect diffusion.

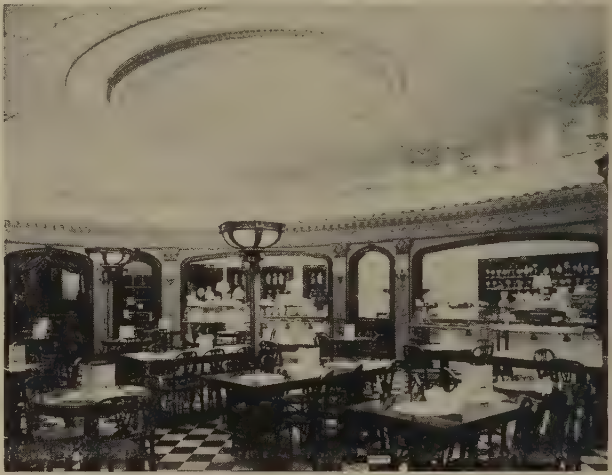


FIGURE 126—Parkside Candy Company, Buffalo, New York. G. Morton Wolfe, Architect. The pedestal method, with supplementary cove units, is an especially appropriate solution for the lighting problem of this high class shop.

A rather novel lighting system has been installed in the hairdressing establishment of Fig. 123. Above each of the dressing tables, in the ceiling, are embedded three special X-Ray reflectors, designed to concentrate their rays upon the person seated at the table. This lighting, which supplements the general illumination of the room, is a remarkable aid to the hairdresser, and is ac-

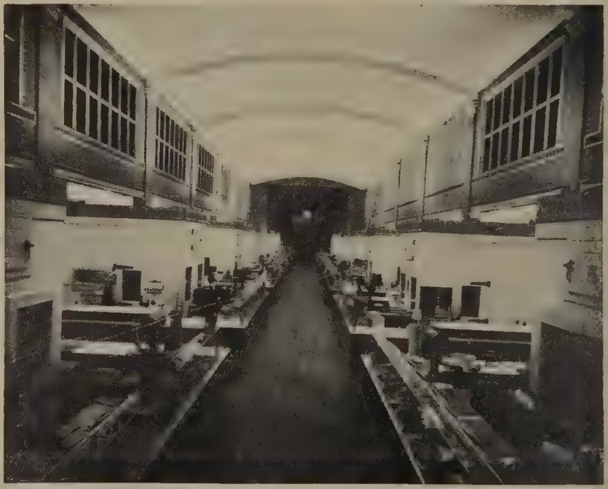


FIGURE 127—Public Market, Norfolk, Virginia. Benjamin F. Mitchell, Architect, Lighting is from equipment mounted on the roofs of the refrigerators and on booths along either side of the center aisle.

complished without the use of any obtrusive equipment, since all mechanical devices are completely hidden from view above the ceiling line. The openings through which the light emerges are finished by a decorative molding. Touches of lighting at the columns accentuate the decorative design.

Candy shops and refreshment parlors are always on the lookout for something distinctive in their furnishings and equipment. Typical of what may be accomplished by thoughtful planning are the shops illustrated in Figs. 124 and 126.

All suspended ceiling fixtures have been omitted in the Parkside Candy Shop. Here also the architectural treatment lends itself particularly well to a unique system of lighting. It will be noted that the room is of an oval shape, with a highly decorated ceiling and ornamental cornice. Three lighting pedestals of special design have been installed, with a strap iron standard supporting a bowl of composition having luminous panels. Contained within the bowl are several X-Ray reflectors, designed for throwing the light to the ceiling. The bases of the pedestals have a grill in each of the four sides, which serves as a heating outlet in winter and for the distribution of cool air in summer. Another special feature is that the pedestals have fastened to them a series of coat hooks near the base of the lighting bowl. In this case the unit serves as a costumer, as a lighting unit, and means for heating and ventilating the room. Supplementing the lighting from the central pedestals is a series of reflectors hidden from view back of the ornamental cornice. Artistic touches of colored light are obtained from the wall brackets and small portable lamps on the candy counters. Altogether this is a very interesting and unusual installation.

Not many years ago the public market concisted chiefly of counters and stalls congregated in the poorer sections of the city. An excellent example of the new tendency in the building of markets is shown in Fig. 127, the City Market of Norfolk, Virginia, which is housed in a beautiful building. This model structure is unsurpassed in facilities for sanitation, and has a scientific lighting arrangement. The lighting of the market is not of the ordinary type, because it is practically all indirect, reflected from the white enamel ceiling, which is 40 feet from the floor. Eighty X-Ray reflectors, each containing a 500-watt lamp, are placed upon the tops of the refrigerators, with their beams directed to the ceiling. The central portion of the market is devoted to meats, which appear to advantage under the clear, even illumination. The fish market is at one side, and the lighting makes it easy for the housewife to be certain of the quality and freshness of the supplies purchased. Proper illumination is of the greatest importance in markets; in fact, in any establishment selling foodstuffs, as it shows the customer exactly what she is getting, and improves the appearance of the product by bringing out its proper colors.

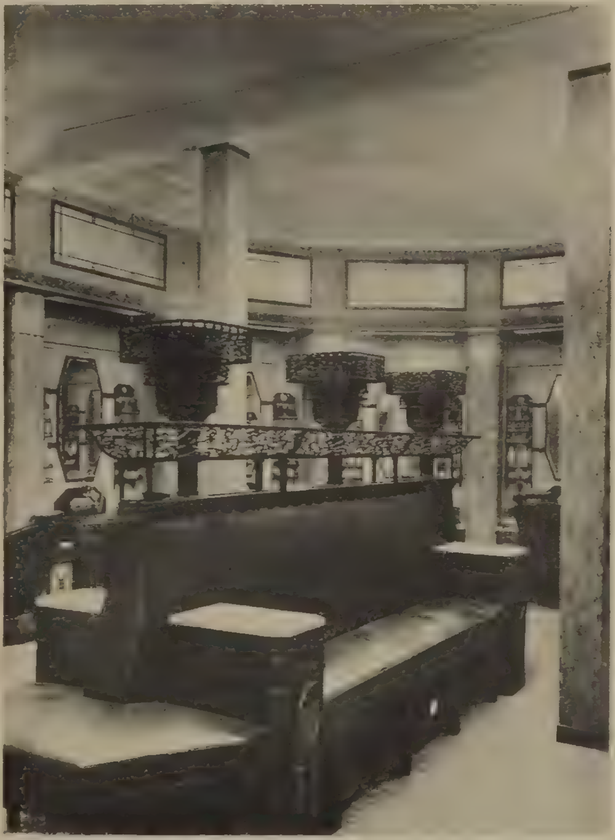


FIGURE 128—Salon de Coiffure, Paris, France. Horn & Curtz, Architects. Indirect lighting from units concealed in pedestals surmounting the seats; a 500-watt lamp in each. Planned by Compagnie des Lamps, Paris.

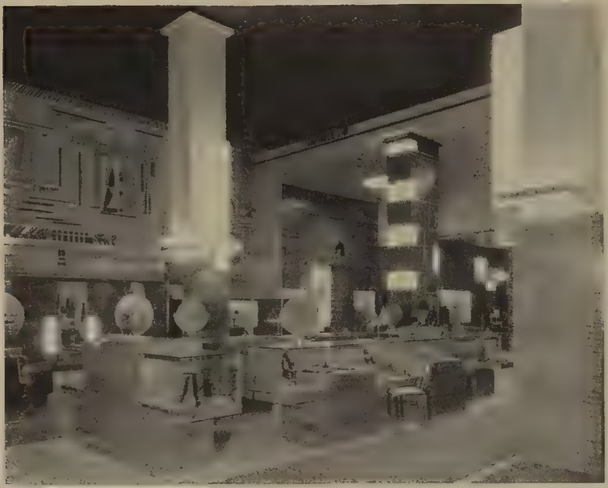


FIGURE 129—Bullock's Department Store, Los Angeles, Calif. John and David Parkinson, Architests; Feil and Paradise, store designers. Typical of the trend in interior treatment for shops, with lighting of appropriate Moderne character.

Department Stores

Too much emphasis has been put upon the cost of good lighting in a store. A system properly planned is not costly, because of the remarkable returns that may be secured for each dollar invested in lighting, in comparison to similar amounts that might be expected from some form of advertising, display, etc. To get the proper comparison, again consider the lighting as a salesman, and the cost for power as the wages paid. Compare this in dollars and cents to the wages of a messenger boy about the store, and it will be found that good lighting can be operated for less than the cost of a clerk in a general office, or an assistant in a maintenance department.

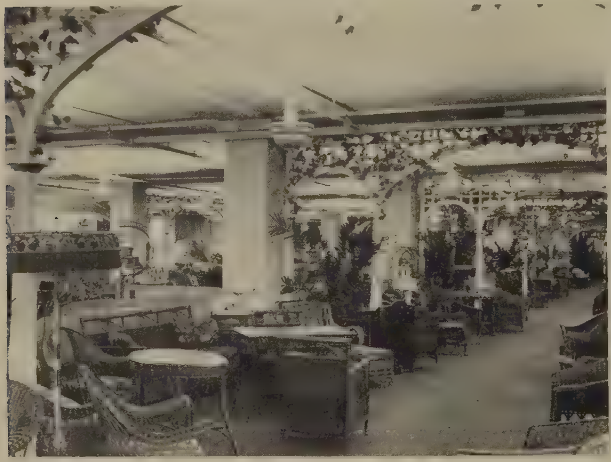


FIGURE 130—The summer furniture section of Marshall Field & Company, in Chicago. Appropriately lighted by opaque indirect fixtures.

One of the largest department stores in Canada, T. Eaton Company, of Toronto, realized the importance of light in merchandising, and after very careful tests, extending over several months, selected a system of indirect illumination, using the type of luminaire shown in the illustration in Fig. 131, the luminous bowl variety, which has been described more in detail on page 40. A 500-watt lamp is used in each of the bowls. All other systems with which the Eaton Company had had experience were objectionable from one standpoint or another. They were a constant source of glare, were distracting the attention of the customer from the merchandise, were not providing comfortable conditions for the shopper, or caused shadows on displays or goods that were being examined by the customer.

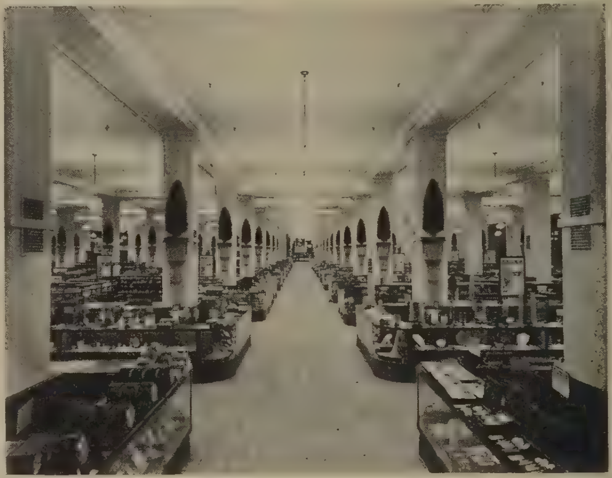


FIGURE 131—T. Eaton Company, Toronto, Canada. The indirect luminaires, each equipped with 500-watt lamp, provide an intensity of eight foot-candles on the counters.

Diffused lighting is the ideal for all types of stores and shops. The method varies in individual cases. One of the most interesting recent examples in which the Moderne method of design in lighting is employed is exemplified by the illustration in Fig. 129, one of the special shops of the Bullock store in Los Angeles, California. Here diffused lighting is obtained from panels of glass set in the columns and wall surfaces, behind which X-Ray reflectors have been installed to obtain maximum efficiency in light utilization. This is what truly might be termed architectural lighting, where light is used as an element in the decorative construction of the interior.

In the Schuster stores of Milwaukee it has been discovered that proper lighting of high intensity increases the sales tone of the establishment, and that sensible illumination is a cheap merchandiser. The several factors influencing the sale of wares are accelerated under plentiful and comfortable illumination, and immediate results in profits fully compensate for the cost of installation and equipment. The stimulating effect in sales is at once noticeable. The cheerful atmosphere created is most desirable. At small increased cost for current the Milwaukee store illustrated was transformed into a beautifully lighted mart. The former system was characterized principally by the amount of glare that it produced.

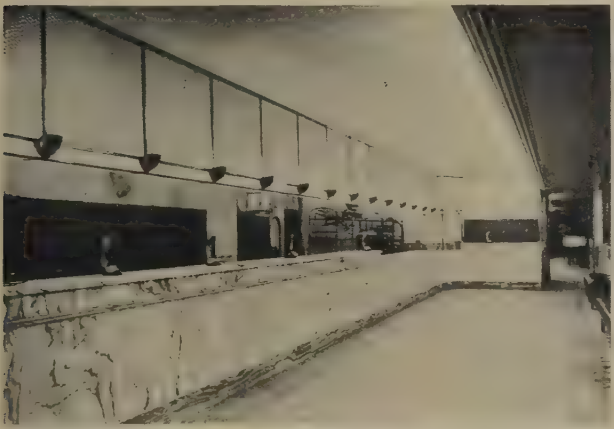


FIGURE 132—Printemps, accommodation department, Paris, France. As part of the interior design shell-like brackets containing X-Ray reflectors on the partition provide the illumination for this space.

In Paris, France, the Printemps store utilizes good lighting in all of its various departments. The first impression is obtained by the illumination of its show windows, which is of a very high standard. The interior of the store has special lighting in many departments, one of which is illustrated in Fig. 132, the accommodation section, with its unusual shell-like ornamental containers bracketed to the glass partitions above the marble counter. Within each bracket is a reflector similar to the type as shown in Fig. 589, designed for throwing its light to the ceiling and giving a truly indirect effect.

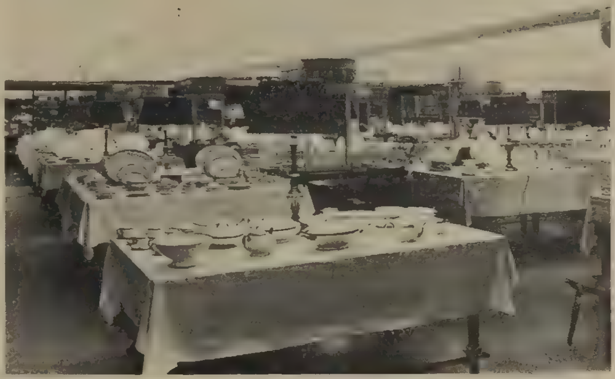


FIGURE 133—China salesroom in low ceilinged basement of a department store. A difficult lighting problem solved by use of Curtis portable table lamps.

Basement sales rooms are most difficult to light. Some of them have ceiling heights that make it impossible to use a pendant luminaire of any kind. This difficult problem was solved in a very clever and admirable way in the chinaware department illustrated in Fig. 133, where the ceiling height is only 8 feet. A series of table lamps was installed for each china display, and equipped with the Curtis adapter for indirect lighting. The system not only is extremely appropriate for the type of display, but also gives an artistic touch.

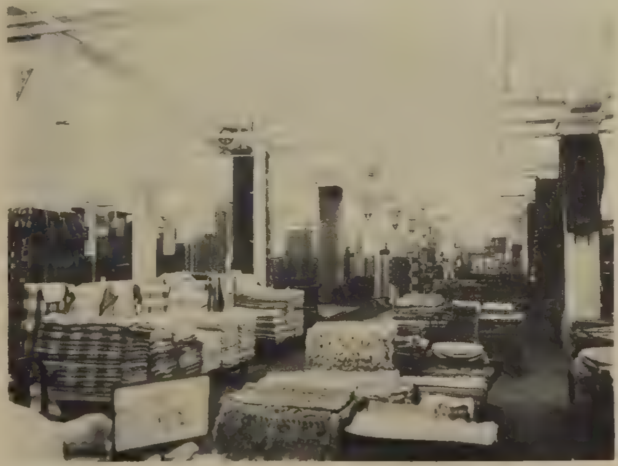


FIGURE 134—The Schuster store, Milwaukee, Wis. High wattage lamps in opaque indirect fixtures illuminate the large area of this selling floor.

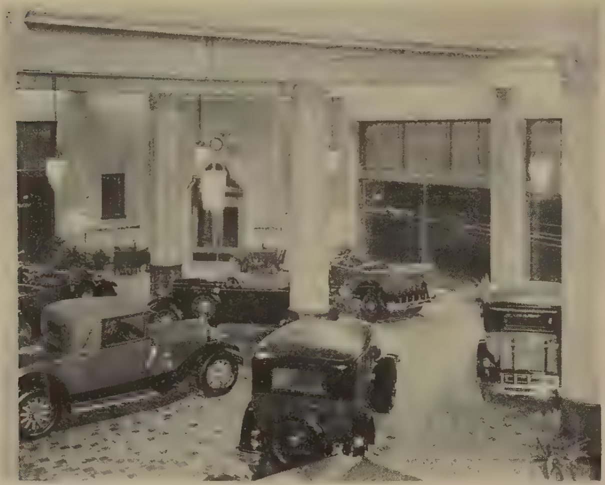


FIGURE 135—The Vesper-Buick Auto Company, St. Louis, Mo. The lantern type fixture of special design, combining indirect and direct lighting, is especially suitable for a salesroom of this character.

Auto Stores

The automobile has become a definite part of our daily life, but, unlike many of our necessities or conveniences, it is not purchased by the average person at frequent intervals. Before the purchase is made, careful consideration is given from many angles. There are discussions and visits to several display rooms, where cars may be seen of the type and price the purchaser has in mind. The consummation of the sale is influenced by several conditions.

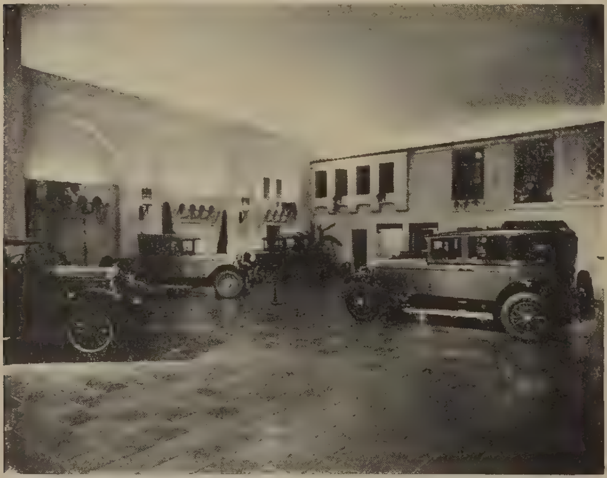


FIGURE 136—Display room of Greer-Robbins Company, Los Angeles, Calif. T. Beverly Keim, Jr., Architect. Novel lighting from side wall arches, with special lantern brackets and cove above the office space.

The prospective purchaser is influenced, of course, by advertising in newspapers, magazines and on billboards; but one of the outstanding factors in making a selection is the attractiveness with which the exhibit is made in the salesroom of the automobile manufacturer. The salesroom which attracts the prospect is the one that causes him to first stop and look. It is the display which attracts him, stimulates his desire to purchase.

Therefore, the impression of a properly equipped, decorated and lighted salesroom is of extraordinary importance. This is especially true because of the fact that most people have leisure in the evening hours. It is then they do their window shopping, and it is then that light plays an

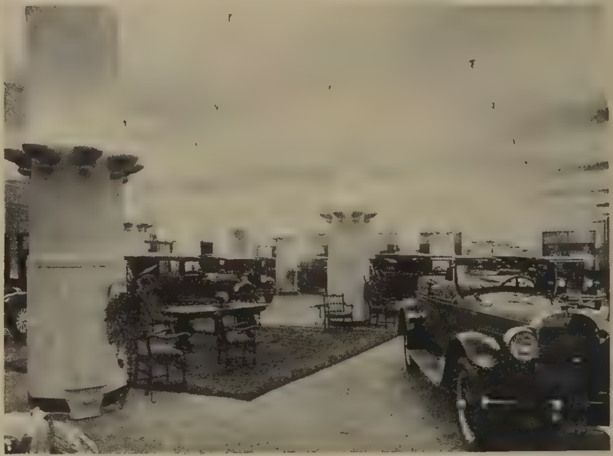


FIGURE 137—Pierpont Motor Co., Pittsburgh, Pa. J. F. McWilliams, Jr., Architect. This large auto display room entirely illuminated by special column brackets containing 200-watt lamps with X-Ray reflectors of the type shown in Fig. 148.

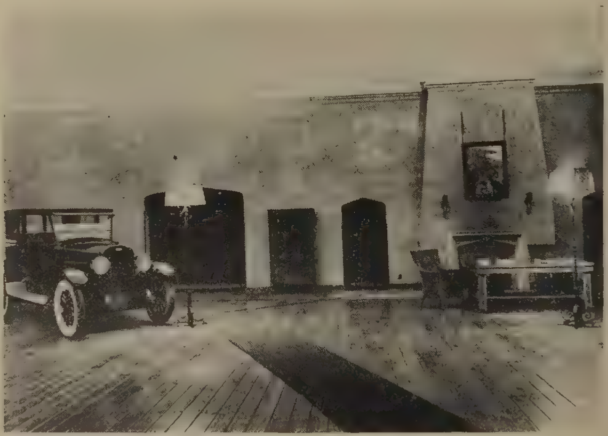


FIGURE 138—A rather unusual method of lighting an automobile display room using the Curtis indirect portable lamp of iron with decorative parchment shade.

important part in leading the prospect nearer to his purchase. Lighting does more than attract. It emphasizes the important features of the automobile—its color, the beauty of its finish, its upholstering, and its pleasing lines.

The illumination of the automobile showroom should be of a moderately high intensity, greater for example, than for a department store. A recent installation in the General Motors display room of Hendrickx & Peeters, of Antwerp, Belgium, uses an extraordinarily effective system of indirect lighting, which produces an average intensity of 18 foot-candles.

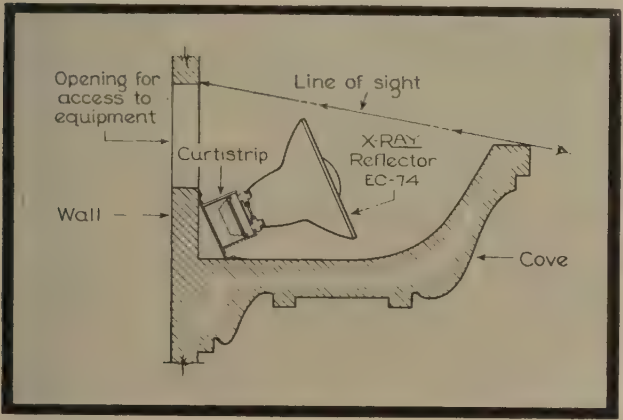


FIGURE 139—Sketch of a cove lighting arrangement suitable for the illumination of room such as shown in Fig. 136.

There are many possibilities in the use of color lighting to emphasize certain features of the car and to provide interesting lighting effects for attraction purposes. These may be accomplished by the ingenious placing of lights throughout the showroom or incorporated in indirect lighting fixtures or coves of proper design. For the most flexible control of installation of this kind the Lumitone, described on page 56, is most appropriate. Such lighting installations, however, must be skillfully planned, otherwise they will detract from the merits of the merchandise on display.

A very important point to remember in connection with the lighting of any displays having enameled, lacquered, painted or polished surfaces is that the reflection or glare from brilliant light sources may appear to the prospect as imperfections in finish, or emphasizes any that may be present. Because of this, indirect lighting has been selected as the most desirable system for automobile and furniture salesrooms. The ceiling becomes the principal source of illumination. It diffuses the entire room with glareless, comfortable and pleasing illumination.

Various methods have been employed for the lighting of automobile salesrooms, some of which are illustrated. The usual method of pendant fixtures is satisfactory and economical. Another system often employed is the use of pedestals containing reflectors of the indirect type. The quality of the illumination is identically the same as received from the indirect lighting units, the method only is different. The idea of lighting from reflectors concealed in a continuous cornice or cove is also a popular one. This scheme lends itself to interesting variations, as far as intensity and color are concerned. In cases where a continuous cove or cornice is not provided or possible, wall urns or wall box cornices, made to conceal a small number of units, have been very successfully employed.

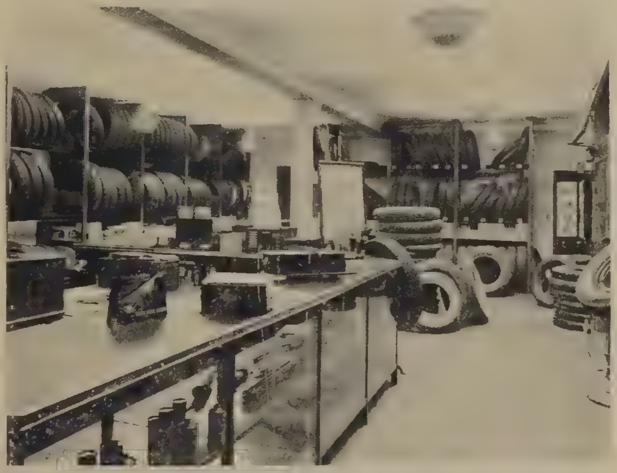


FIGURE 140—Woodward Bros. Tire Shop, Niagara Falls, N. Y. Kirkpatrick & Cannon, Architects. Lighting installation of quality in an establishment selling quality merchandise.

Methods of merchandising and display for automobile accessories are rapidly changing. Systematized methods of storing the merchandise have been adopted. Case displays have been installed; in fact, the whole establishment has taken on a very businesslike aspect.

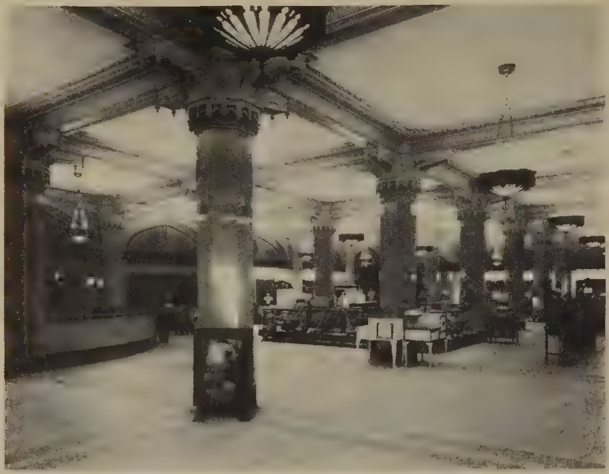


FIGURE 141—The salesroom of the Oklahoma Gas & Electric Company, Oklahoma City, Okla. Layton, Hicks & Forsyth, Architects. Luminous bowl composition fixtures, each equipped with 5 X-Ray reflectors for 200-watt lamps, provide excellent illumination.

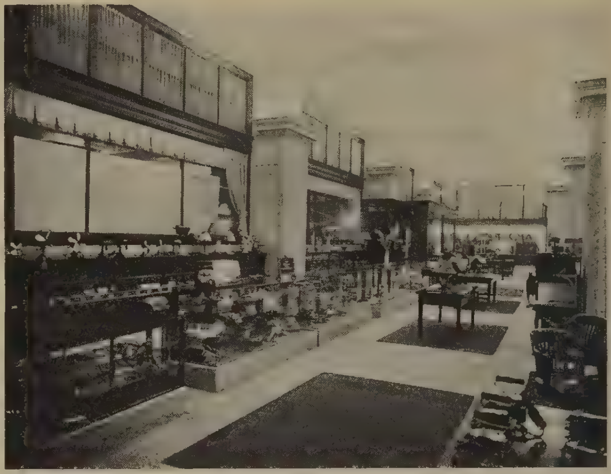


FIGURE 143—The electrical shop of the Tennessee Electric & Power Company, Chattanooga, Tenn. Charles Bearden, Architect. This salesroom is lighted entirely from the columns and the cornices, whose mouldings have been enlarged to hide the X-Ray reflectors.

Electrical Shops

A great change has come about in the last few years in the design and equipment of electrical shops. The electrical store of the present day has lost its wareroom appearance, and has the new atmosphere, an inviting and pleasing appearance. Buyers of electricity very naturally look to their electric companies to show them the best and most modern ways of using light.

Accordingly, the Union Electric Light and Power Company, of St. Louis, set up in its own store and in its show windows, in fact, in its entire building, examples of the latest achievements in modern scientific illumination. In the store interior the average intensity of the illumination is about 22 foot-candles. There is no visible light source. the lamps are concealed in the deep trough that runs the length of the walls and surrounds the pillars. The light is sent upward to the ceiling and reflected downward in even radiance.

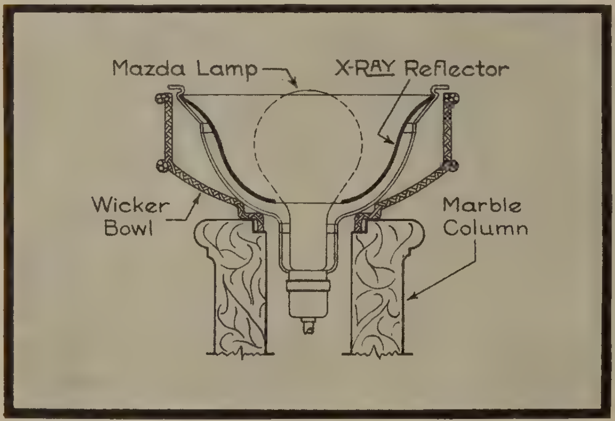


FIGURE 142—Detail of lighting scheme employed in the installation pictured in Figure 144.

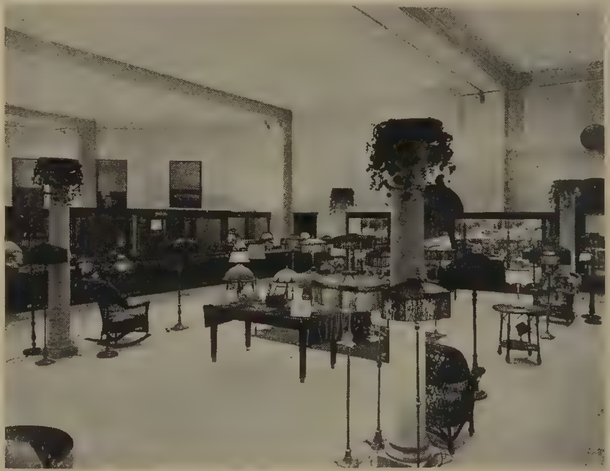


FIGURE 144—Electrical store, New York & Queens Power Company, Ridgewood, L. I. The architect was Mr. L. Knowlen. The lighting pedestals supply a high intensity, with no visible light source.

In order to complete the atmosphere of confidence, stability and harmony of the installation, and the desire to have and to buy, the salesroom must be well lighted. Good lighting is the kind that is comfortable to see by, the kind which completely illumines the store to a sufficient intensity,

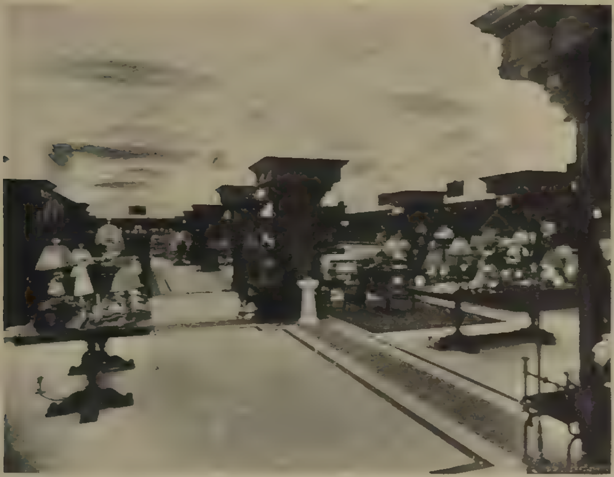


FIGURE 145—The main electrical display room of the Union Electrical Light & Power Company, St. Louis, Mo. Albert Groves, Architect. A splendid, dignified installation of column lighting delivering an average intensity of 22 foot-candles.

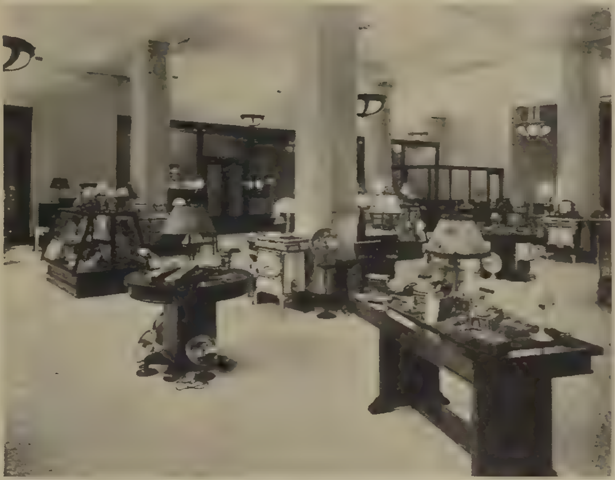


FIGURE 147—Electrical salesroom Ottawa Electric Company, Ottawa, Canada. Planned by the Eclipse Plating & Sales Company. Effective lighting for a typical shop of the central station industry.

creates a cheerful atmosphere and makes the merchandise look attractive. Properly planned and used, lighting can be made one of the electrical store's best salesmen. A salesroom lighted from concealed sources has nothing to distract the attention, but gives the best illumination possible, to say nothing of the unusual character that it lends the establishment.

Believing in the principle of teaching by example, the New York & Queens Electric Light and Power Company makes use of Curtis Lighting equipment to produce unusual yet serviceable lighting effects in its showrooms. X-Ray reflectors are concealed along the tops of the partitions and in the wicker baskets that surmount the several large pedestals shown. The light from these reflectors is evenly distributed over the entire building, eliminating glare and shadows, and producing a very pleasing effect.

For its electrical shop the Tennessee Electric Power Company, of Chattanooga, has utilized a system of concealed lighting from a cornice four feet from the ceiling, which runs around the room. The reflector employed is shown in Fig. 148.

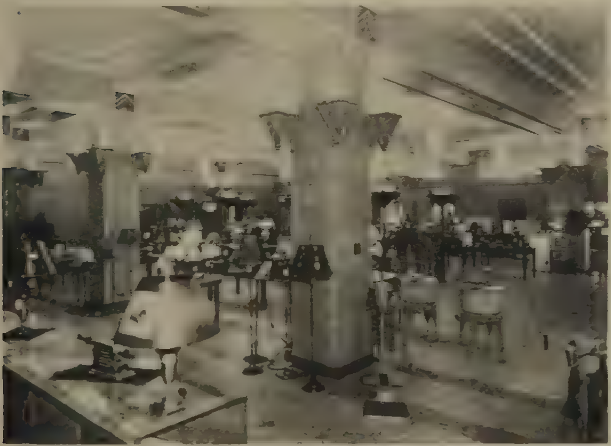


FIGURE 146—Main sales floor of the Public Service Company of Northern Illinois, Joliet, Illinois. H. V. Von Holst, Architect, Chicago. Post urns and pedestal lighting give an appropriate atmosphere for this modern interior.

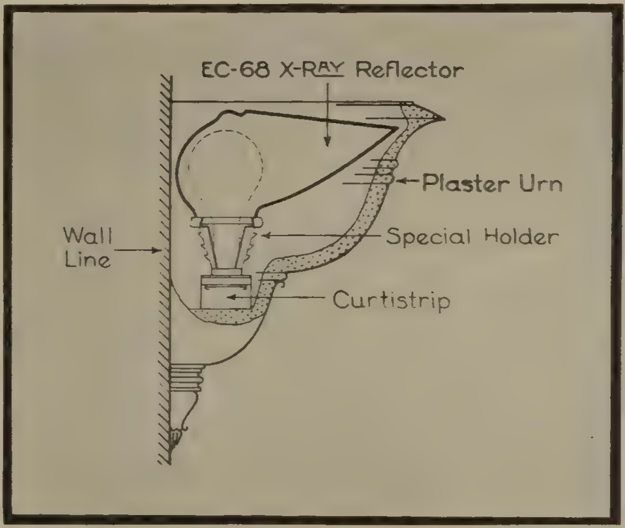


FIGURE 148—Diagrammatic section of an urn suitable for mounting on walls and columns, showing proper installation of the X-Ray reflector EC-68.

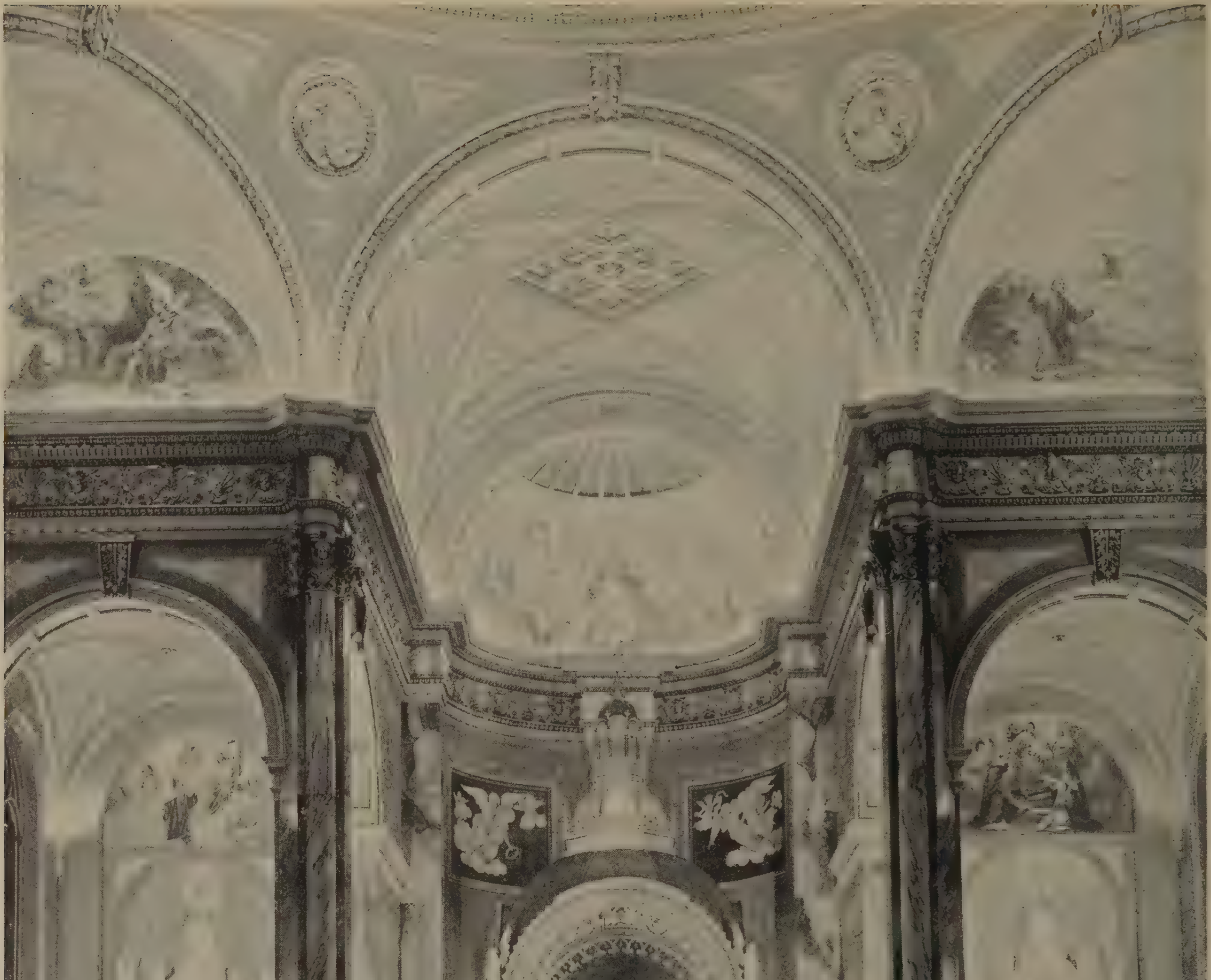


FIGURE 149—A view of the sanctuary and side altars of St. Josaphat's Church, Milwaukee, Wis. Breilmaier & Sons Co., Architects. A beautiful example of church lighting with all lighting equipment entirely concealed from view.

CHURCHES

IN THE church light has always been a medium of spiritual and symbolic expression. The early Gothic and Romanesque churches were not brightly lighted either by natural or artificial means. As a matter of fact, these churches were used very little at night. Light for reading was almost unnecessary; very few people could read. General lighting methods, as we understand them today, were not employed.

Recently, in speaking of church lighting, Mr. E. Donald Robb stated that the lighting equipment and fixtures for churches furnishes one of the very few instances for which we have no mediaeval precedent to draw upon in the furnishing of our houses of worship. The task of the modern lighting designer, therefore, assumes no small proportions in consequence of the vast variety of church buildings being erected throughout the land, and because of the total lack of analagous examples which so greatly assist the other arts.

Is it to be wondered at, then, that an excursion through any town or city of our country will disclose the fact that our churches are, as a general rule, badly lighted, and with luminaires little adapted for their use, either in harmony of design or the quality of lighting they produce?

The prevalence of innumerable sects and denominations of the Christian church in our country is accounted for by the fact that in the Constitution of the United States we find "that no religious test shall ever be required as a qualification for any office or public trust," and "that Congress shall make no law respecting the establishment of

FIGURE 150—It is from the rare old examples of ecclesiastical art that we get our inspiration for modern houses of worship.

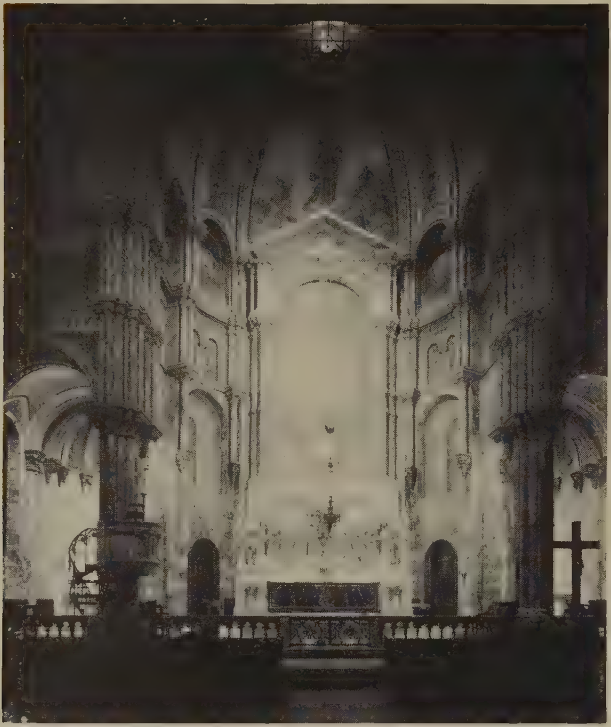


FIGURE 151—Altar of Our Lady of Mercy Church, Philadelphia, Pa. An exquisite lighting effect produced by concentrated illumination from X-Ray reflectors placed above the skylight in the dome of the sanctuary.

religion, or prohibiting the free exercise thereof." Because of our cosmopolitan makeup we have a variety of religious edifices greater than for any other country in the world. The houses of worship in the foreign districts of our great metropolitan cities echo the native land from which the parishioners migrated. The church builder in America, therefore, has a great task before him in the multitude of problems in design.

The lighting of churches probably requires more careful thought than for any other type of building. We know how necessary good lighting is. We appreciate its qualities as a revealing agent and its functions for producing comfort and a restful, meditative atmosphere. Yet many beautiful churches exist with hideous lighting. On the other hand, many buildings of bad architectural design have illumination of pleasing quality. The ideal condition in this respect, of course, is architectural perfection revealed by appropriate lighting thoughtfully and harmoniously planned.

One of the most unusual and effective methods of sanctuary lighting is shown in Fig. 152, an illustration of the Holy Name Cathedral in Chicago. It was before this altar that hundreds of thousands bowed in reverence during the week of the Eucharistic Congress in 1926. The altar was made a beautiful spectacle by powerful concealed floodlighting units.

Chancel and Sanctuary

The sanctuary or chancel is first in importance, the center of interest, especially in the church with an elaborate ritual, and it should be flooded with light. Concealed lighting methods are most appropriate, as shown by the illustrations on these pages. Pendants of low brightness, giving a decorative glow, or brackets with deeply shaded lights are frequently and very appropriately installed. The principal lighting, however, for the altar should come from concealed sources. Decorative standards around the altar may be equipped with candle lamps frosted, which tends to reduce their brightness. Where candles have a symbolic value they should not be replaced by electric lights imitating the shape of the candle.

The picture in Fig. 153 illustrates a chancel lighting method employed by a prominent church architect. The suspended luminaires of small scale consist primarily of a perforated metal band supporting an antique glass bowl. The purpose of

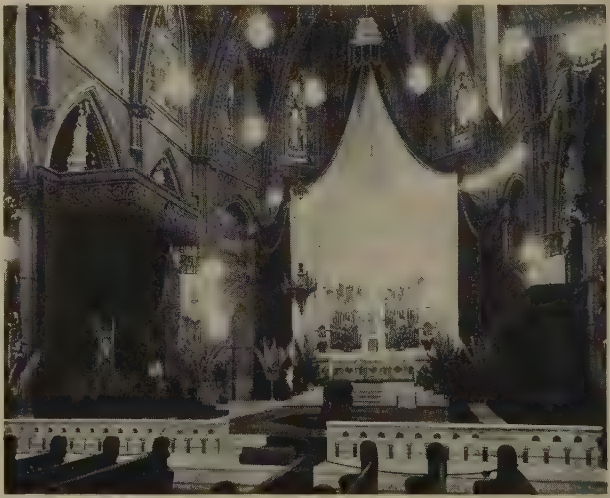


FIGURE 152—Sanctuary of the Holy Name Cathedral, Chicago. Eight 500 watt floodlights hidden from view cast their light upon the altar and baldachin.

the fixture is not so much to give reading illumination for the choir, but is to be considered as a part of the furnishing of the chancel. A glowing bowl of low brightness supplies a restful point of light.

There are many instances where a single chancel or sanctuary light is preferable, but the use of an arrangement as shown in Fig. 153 prevents any obscuring of view of beautiful art glass windows and reredos or altar. Furthermore, the slender suspension of a great number of small fixtures accentuates the chancel's lofty appearance.

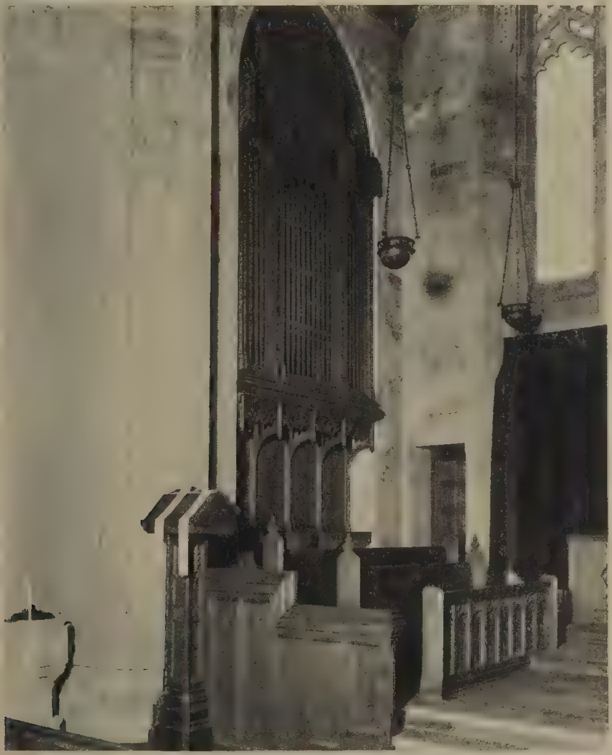


FIGURE 153—Chancel of Bryn Mawr Community Church, Chicago. Granger & Bollenbacher, Architects. Pendant luminaires supplemented by reflectors concealed behind the chancel arch permit a full free view of the art windows and reredos.

Auditorium

We find in making a survey of the nave or auditorium lighting that the imagination of the architect and the lighting man has produced many interesting variations. One system or method will not serve all purposes, will not satisfy all lighting and architectural requirements. Hence we have direct lighting methods, indirect lighting, cove lighting, lighting by concealed or partly concealed devices, etc., all to complicate and yet make more interesting the problem of church illumination. The handling of this problem determines the effectiveness of the architecture and produces the characteristic atmosphere of the house of worship.

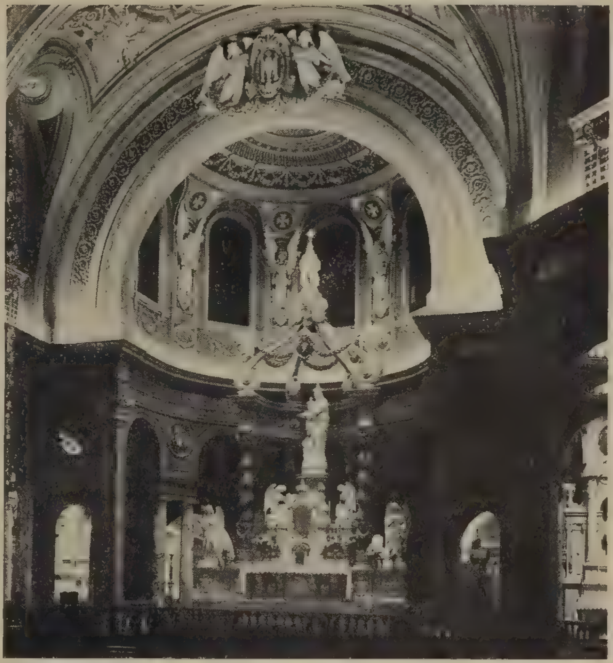


FIGURE 154—Altar of Our Lady of Victory Shrine, Lackawanna, N. Y. Emil Ulrich, Architect. Only by careful planning can the magnificent beauty of statuary and paintings be properly revealed.

Indirect lighting has become a popular and ex-

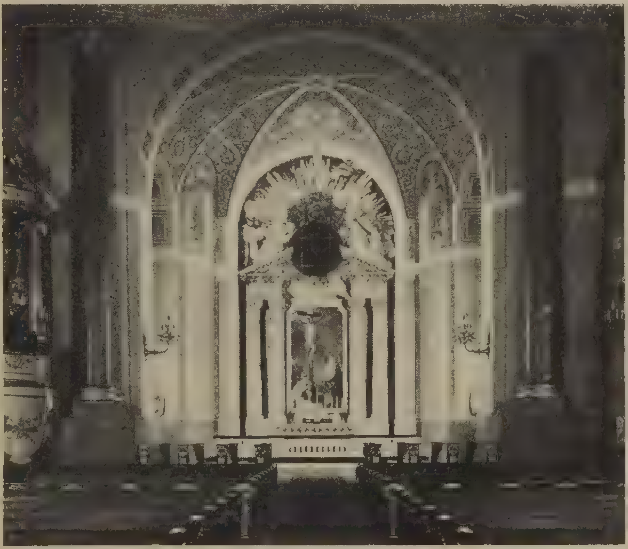


FIGURE 155—Östermalmskyrkan, Stockholm, Sweden. In addition to providing light for the choir, concealed reflectors bring the altar into brilliant prominence.

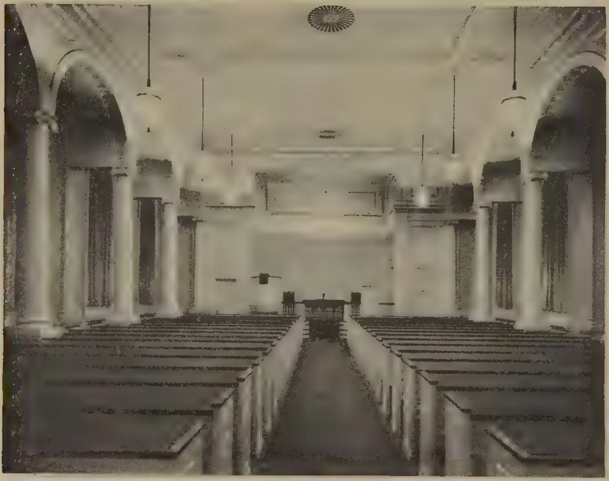


FIGURE 156—Unitarian Church, Omaha, Nebraska. John & Allen McDonald, Architects. A simple but very appropriate lighting for this interior, in keeping with the architectural design.

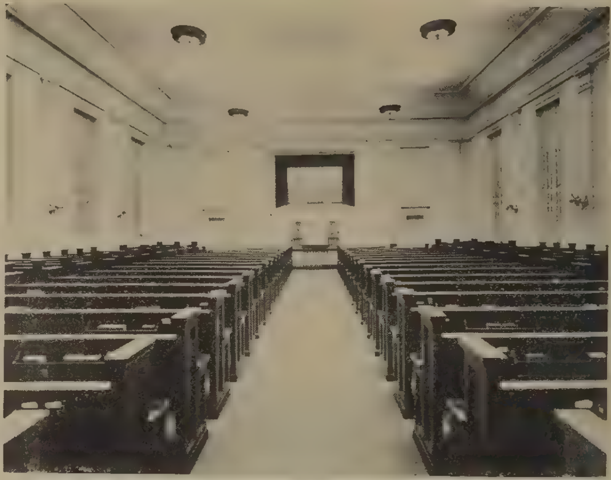


FIGURE 158—Vineville M. E. Church, Macon, Ga. Dunwody & Oliphant, Architects. Excellent illumination with the minimum of luminaires provides the atmosphere desired by the architects.

ceptionally happy solution for many church lighting problems; not only because of the quality of the illumination, but also because of its effectiveness in revealing architectural detail. The lighting of the church auditorium should not be placed upon a basis of intensity or foot-candle values. It is most important to provide the proper atmosphere, both by harmony of design in the luminaire and by producing the appropriate quality of illumination.

It is well to keep in mind that the auditorium should not be overlighted. Too much light is more harmful in destroying the atmosphere of the interior than too little. Although a reading intensity is necessary, it is not desirable that the illumination should take on the character of that provided for an office as far as foot-candle values are concerned. The auditorium or nave lighting should not in any way detract from that of the chancel or sanctuary. The luminaires in the church should always be as inconspicuous as possible, small in scale and unobtrusive, and in few cases elaborate in design. The tendency of the designer should be towards the greatest simplicity possible, consistent with the lighting results to be obtained and the harmony of the interior.

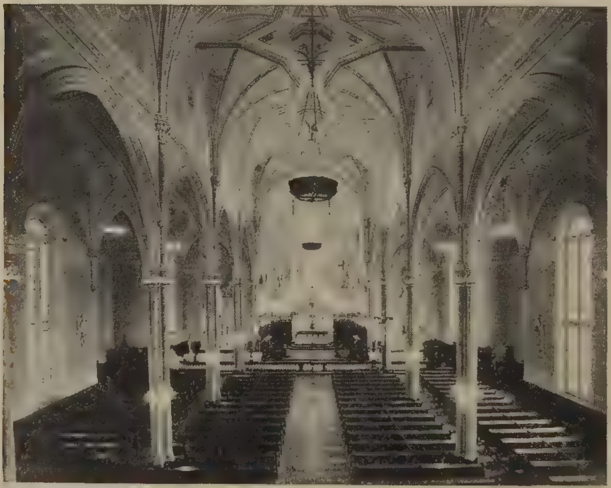


FIGURE 157—St. Brigid's Church, Ottawa, Canada. Eclipse Plating & Sales Company, Contractors. An old edifice relighted with great effectiveness, using modern methods.

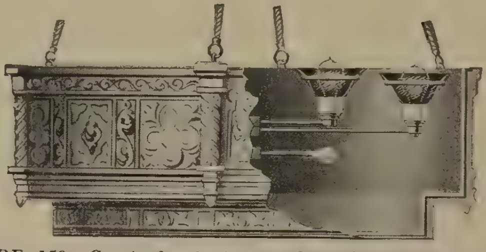


FIGURE 159—Curtis luminaire used in St. Brigid's Church. Ottawa. Cutaway portion discloses the relation of reflectors and lamps within the bowl.

The location of the fixtures or lighting equipment is usually determined by architectural or structural conditions, whether the light be of a concealed nature or consist of a series of suspended units. In the cathedral type church luminaires are suspended principally in two lines, either from the beams or between the beams, de-

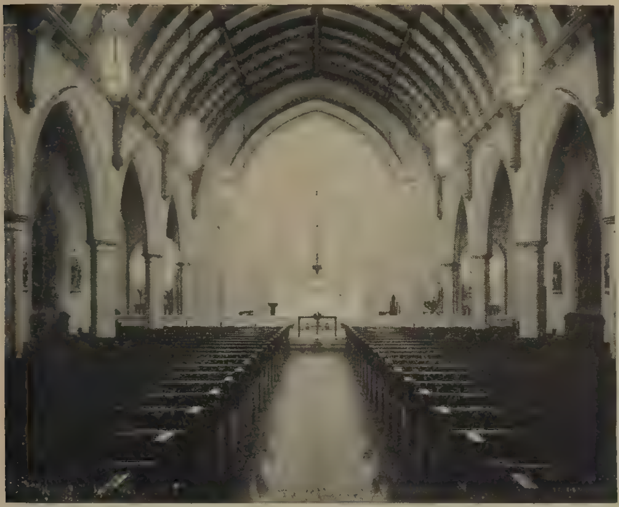


FIGURE 160—St. Joseph's Church, Rensselaer, N. Y. W. H. Van Guysling, Architect. A beautiful Gothic luminaire of harmonious design is used, with sides and bottoms of amber cathedral glass, giving a pleasing tinted glow with adequate general lighting.

pending upon the relative size and importance of the side aisles. If it is desired to borrow considerable light from the nave for the side aisles, the practice of suspending the fixtures opposite the arched opening between the columns is preferable. Frequently in the square type of church auditorium, where the ceiling is beamed, the logical location for suspending the fixtures is from four points at the crossing of the ceiling beams.

Recommendations in regard to the intensity of illumination desirable for church lighting are to be found on page 279. Information concerning the methods of planning and details of calculation for church lighting installations will be found in the discussion on page 295.

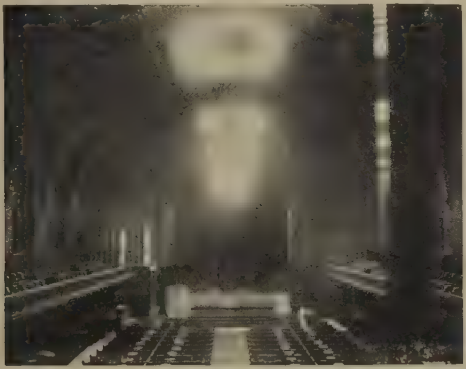


FIGURE 161—Calvary Presbyterian Church, Philadelphia, Pa., with old lighting system. The glare from exposed lamps handicaps the minister and is a menace to the audience.

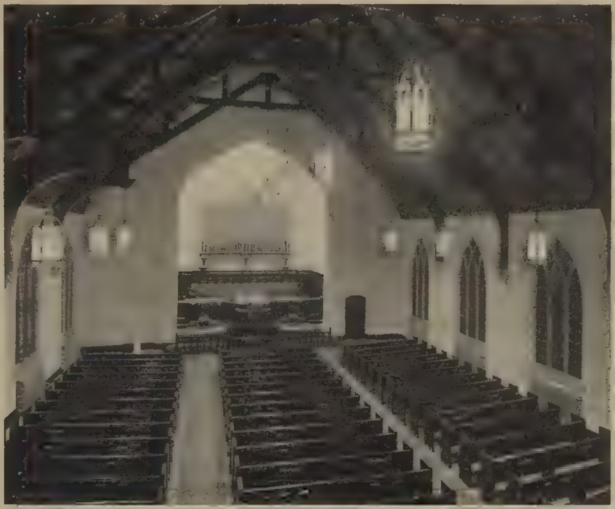


FIGURE 162—M. E. Church, Greensburg, Indiana. The lantern fixture provides general illumination with strong downward component through the bottom of the luminaire. Light is also thrown to the ceiling by reflectors concealed in the top.

Lantern Fixtures

A favorite type of luminaire for the modern church is the lantern fixture. This may consist purely of a direct or diffusing unit, or it may be strictly indirect in character, casting all of its rays to the ceiling, whence the light is reflected throughout the auditorium space. On the other hand, the lantern may have components of direct and indirect lighting, some light being cast directly downward, some to the ceiling, with glass panels in the fixtures illuminated by auxiliary lamps.

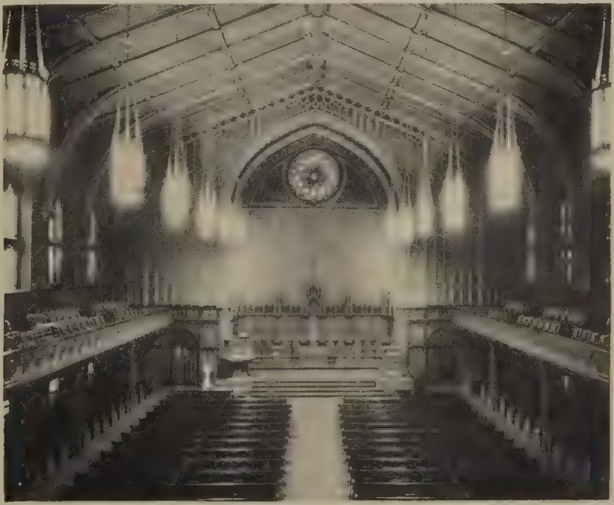


FIGURE 163—Calvary Presbyterian Church, Philadelphia. J. F. Buchanan & Co., Contractors. The same interior is pictured at the left but with an old lighting system. Note the effectiveness of the new illumination method.

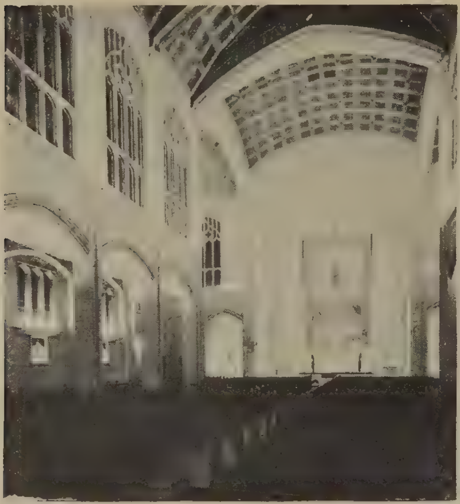


FIGURE 164—St. Thomas Aquinas Church, Chicago. K. M. Vitzthum & Co., Architects. Unique lighting, reflectors concealed in the ledges.

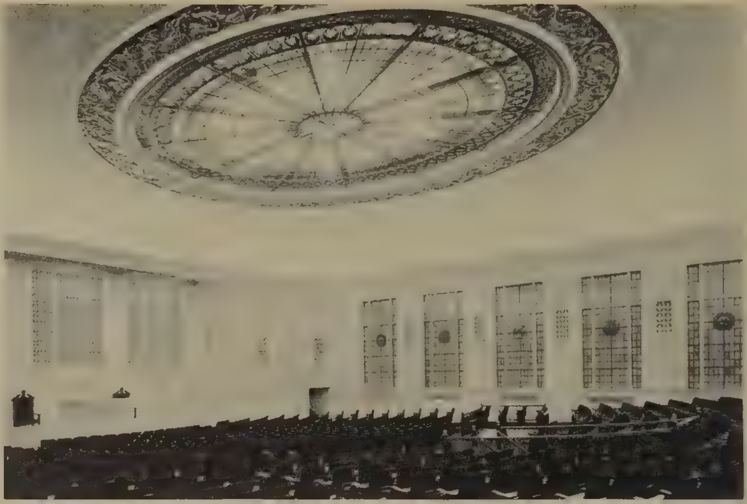


FIGURE 167—Fourth Church of Christ Scientist, Detroit, Mich. Weston & Ellington, Architects. The flatness of the ceiling is relieved by skylight above which reflectors and lamps are placed to supplement cove lighting.

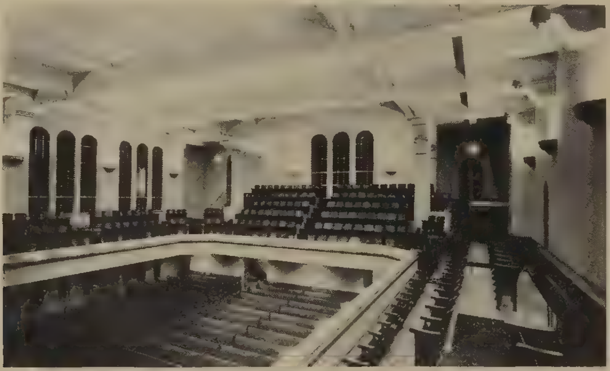


FIGURE 165—First Baptist Church, Spokane, Washington. Whitehouse & Price, Architects. Lighting equipment is installed in balcony rail and in wall urns.

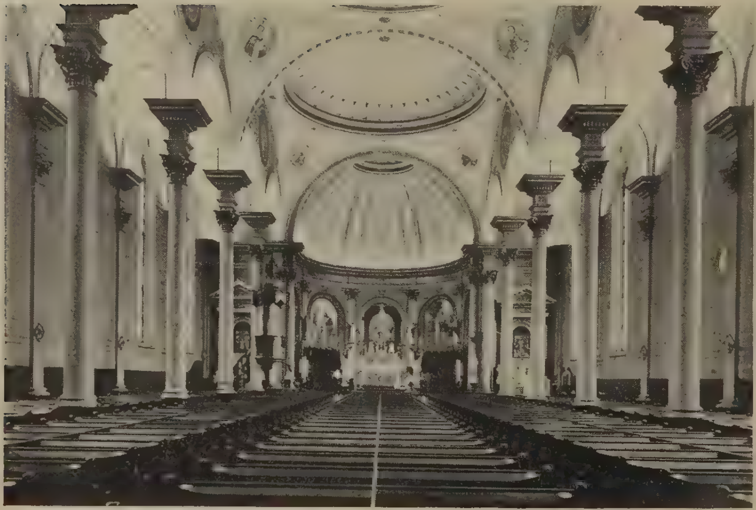


FIGURE 166—St. Jean Le Baptiste Church, Ottawa, Canada. X-Ray reflectors concealed around tops of columns and in the cove above the sanctuary.

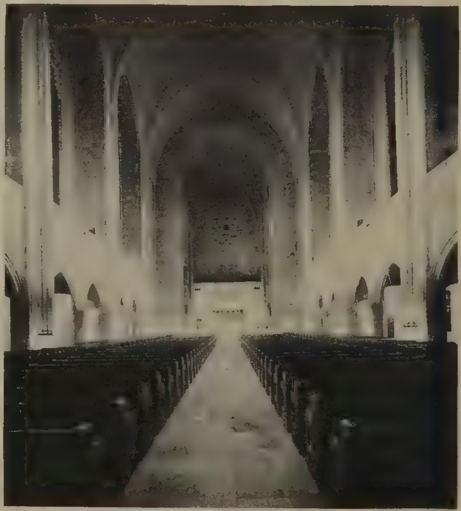


FIGURE 168—Church of the Heavenly Rest, New York. Mayers, Murray & Philips, Archs.

Special Lighting Methods

One of the newest methods of lighting the church is by means of concealed reflectors placed within receptacles provided in the ledges of the clearstory and side aisle windows. An interesting example is given in Fig. 164, where the lighting effects exemplified are the result of the cooperative efforts of the parish priest, the architect and the lighting engineer.

The illusion of golden sunlight filtering down through a glass skylight has been produced with great success in a number of churches, large and small. This warm artificial daylight illumines the entire auditorium without glare. Skylight lighting may be produced very simply. A series of X-Ray reflectors may be mounted above the diffusing glass, which, if properly selected, gives high lighting efficiency. Such a system of illumination is highly practical in church auditoriums whose construction allows it. In Fig. 167 the skylight has been utilized as a decorative feature designed in the form of an enormous rosette.

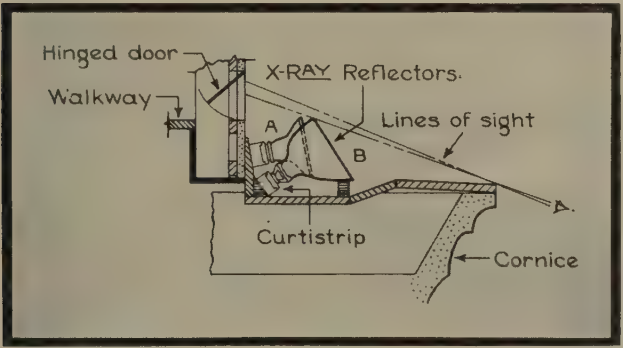


FIGURE 169—Detail of the method employed for the lighting of the dome of St. Josaphat Church, in Milwaukee, Wis.

Advantage is frequently taken of the architectural elements of an auditorium for the concealment of lighting reflectors, as shown in Fig. 166. By enlarging the caps of the columns a very beautiful effect has been produced, revealing the decorative ceiling of the church and producing a lighting effect of comfortable and harmonious quality.

For the Church of the Heavenly Rest in New York City, illustrated in Fig. 168, a very unique lighting system has been devised. Illumination for the nave comes from lamps and reflectors concealed entirely from view along the walls of the triforium gallery. The beams of light from the equipment are directed towards the opposite wall to the area just above the arched openings to the side aisles. By reflection from the stone surface the light is diffused throughout the auditorium space. The ceiling is kept in darkness, thus enhancing the sense of mystery and contributing to the atmosphere that the architect desired to produce.

Rarely do we encounter a great dome whose surface is covered with magnificent paintings, such as is to be found in the St. Josaphat's Church illustrated in Fig. 170. That these paintings might be properly revealed a special lighting equipment was installed in the cornice at the base of the dome, flooding the interior with light. By the careful placing of the reflectors a perfectly even distribution is obtained over the entire surface of the dome, as indicated by the illustration.

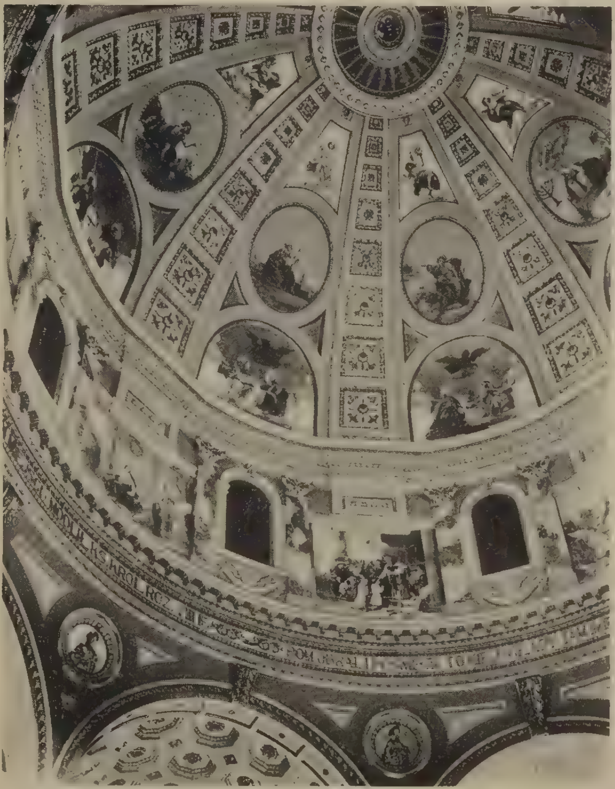


FIGURE 170—Dome of St. Josaphat's Church, Milwaukee, Wis., shows the effect of indirect lighting in the revealing of the mural decorations. Lighting equipment is concealed in the cornice above the inscriptions.

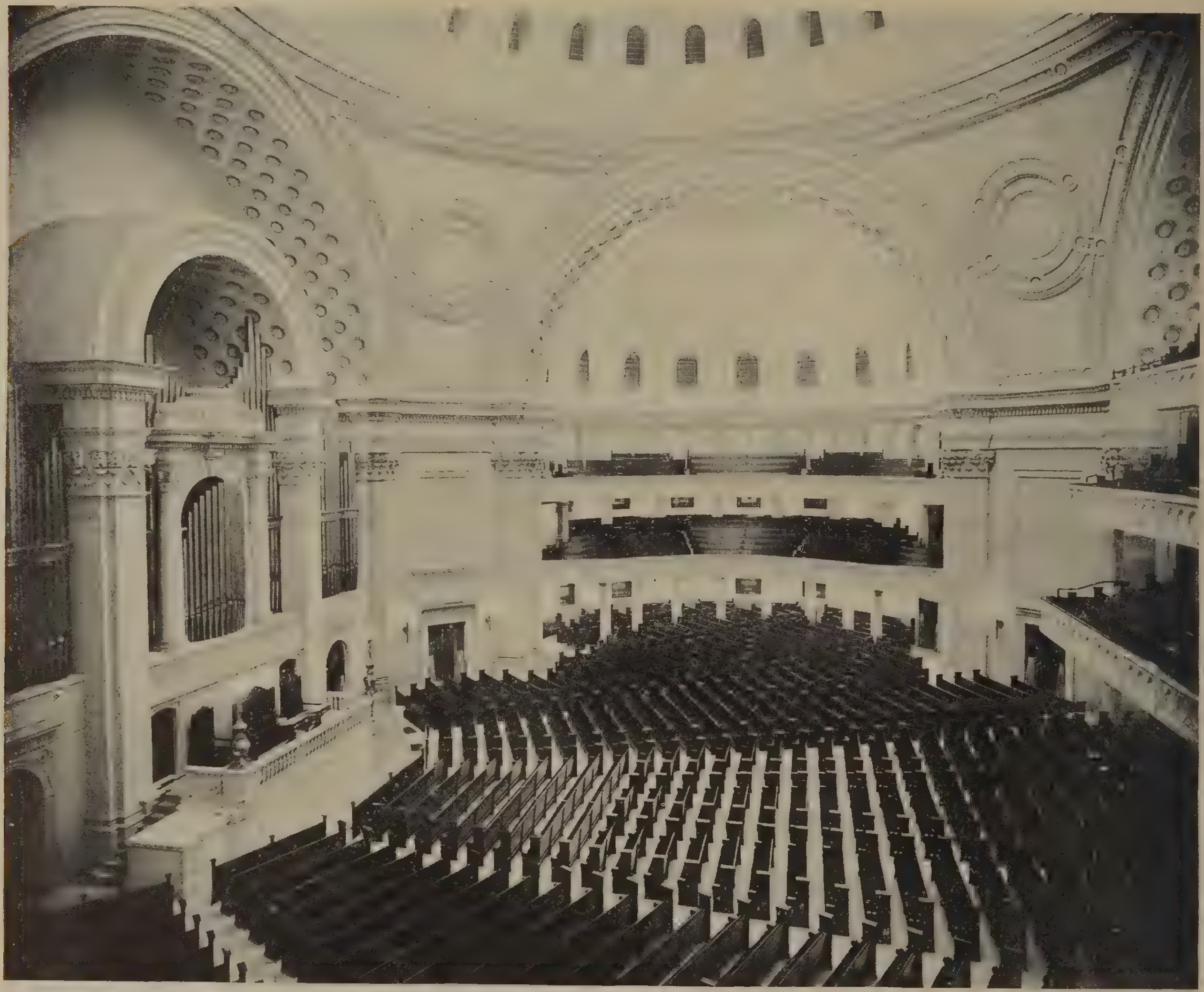


FIGURE 171—First Church of Christ Scientist, Boston, Mass. M. B. Foster Electric Co., Contractors. This large and magnificent church is relighted with the new type of a "reversed cove" system.

For the lighting of the First Church of Christ Scientist in Boston some entirely new principles were employed, especially in the auditorium.

The system finally adopted and installed is illustrated in a diagrammatic way in Fig. 172. The type of lighting might be called the "reversed cove" method, inasmuch as the equipment is placed at the top of the dome rather than at the base, with the light directed from above to the sides of the dome, from where it is diffused downward into the auditorium area. The removal of the pendant luminaires increases greatly the sense of vastness of the interior, inasmuch as they had no logical place in the architectural scheme.

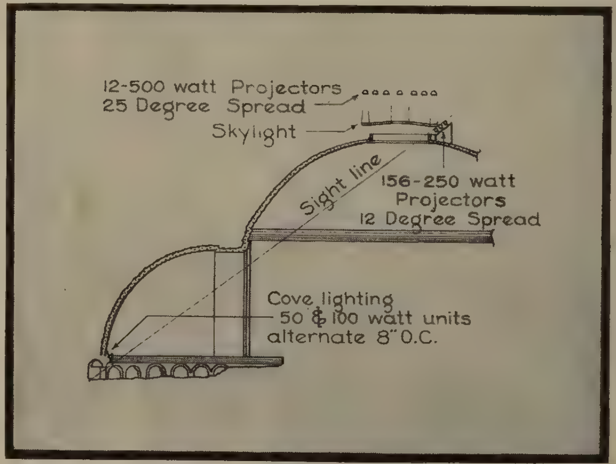

12-500 watt Projectors
25 Degree Spread
Skylight
Sight line
156-250 watt Projectors
12 Degree Spread
Cove lighting
50 & 100 watt units
alternate 8" O.C.

FIGURE 172—Diagram showing the method used for the illumination of the dome of The First Church of Christ Scientist.

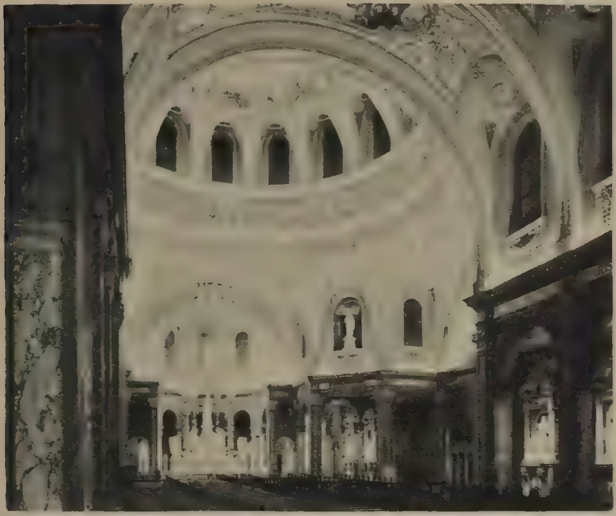


FIGURE 173—Our Lady of Victory Shrine, Lackawanna, N. Y. Emil Ulrich, Architect. Works of art are properly revealed for the inspiration of the audience by careful placing of the lighting units. Note the lighting for the Stations of the Cross.

Cove Lighting

Cove lighting is one of the most effective yet most difficult methods to properly apply. It has been widely adopted because of the fact that the reflecting devices can be easily hidden in the architectural elements of the structure. The idea of compactness should be in mind in providing the mechanical equipment for producing the lighting results, so that no architectural feature will be over-emphasized.

We cannot doubt the inspirational effect and the increase of appreciation for the beautiful that have resulted in the single act of lighting manipulation in the shrine shown in Fig. 173. As Dr. Cram would say: "This is a temple reared about an altar, growing richer and more splendid as it approaches the sanctuary, where is concentrated the wealth of obedient and loving workmanship." The atmosphere of quiet beauty contributed by harmonious lighting gives this interior a charming touch of magic. The psychological effect of suitable illumination may be brought to bear nowhere quite as much as in the church.

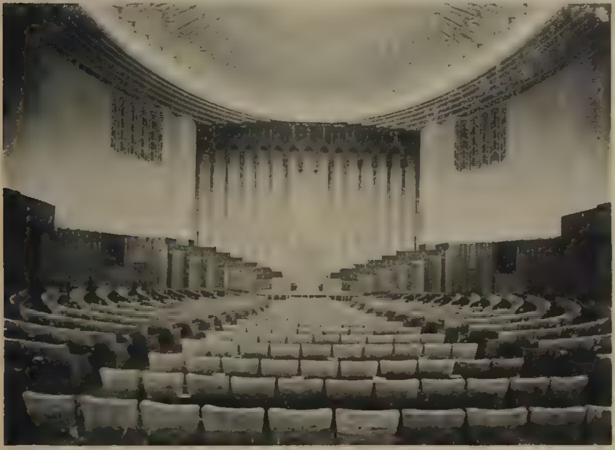


FIGURE 174—Boston Avenue M. E. Church, Tulsa, Oklahoma. Rush, Endicott & Rush, Engineering Architects. Miss Adah Robinson, Designing Architect. A carefully planned cove lighting installation in a church of modern design.

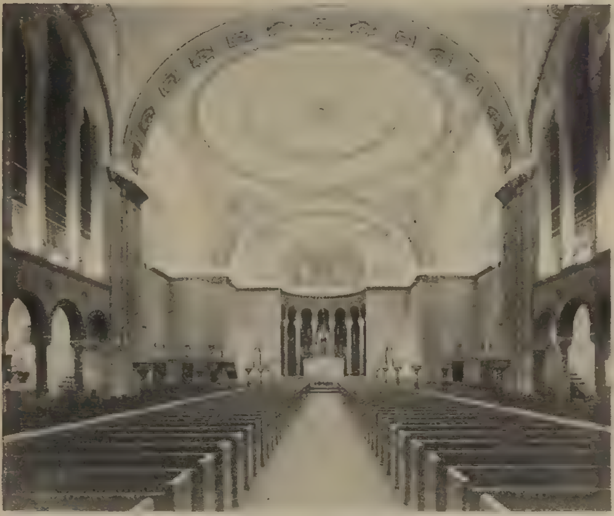


FIGURE 175—Church of the Transfiguration, Philadelphia, Pa. Henry D. Dagit & Sons, Architects. Small reflectors closely spaced are concealed in the cornice and window ledges, eliminating entirely the necessity of using obtrusive pendant fixtures.

The Boston Avenue M. E. Church in Tulsa, Oklahoma, has created in architectural circles a great deal of comment, because of the fact that it is the first large church in America to be designed along the lines of modern art. The architects, Rush-Endicott-Rush, may be considered as pioneers, because of the fact that their departure is so radical from the usual church architecture.

Unique lighting effects were planned for various portions of the building. The main auditorium, illustrated in Fig. 174, is equipped with indirect cove lighting as the exclusive method for this portion of the building. The room is circular in form and has a seating capacity of 2000. The lighting for the auditorium is from three coves and an illuminated skylight.

As an innovation in church illumination, the cove lighting is arranged for a two color combination, each light being controlled separately so that half of the auditorium may be used at a time. A series of dimmers is used in circuits with the lamps when a change in intensity is desired.

Miscellaneous Lighting

We should not overlook the fact that the church auditorium is not the only space in the edifice that requires special illumination. Very frequently too little study is given to the lighting of such departments as social rooms, club rooms, class rooms, baptistry, narthex, recreation rooms, gymnasium and locker rooms, exterior, kitchens, pastor's study, passages, vestibules, lobbies, sacristies, stair halls, stations of the Cross, shrines, porches and entrances.

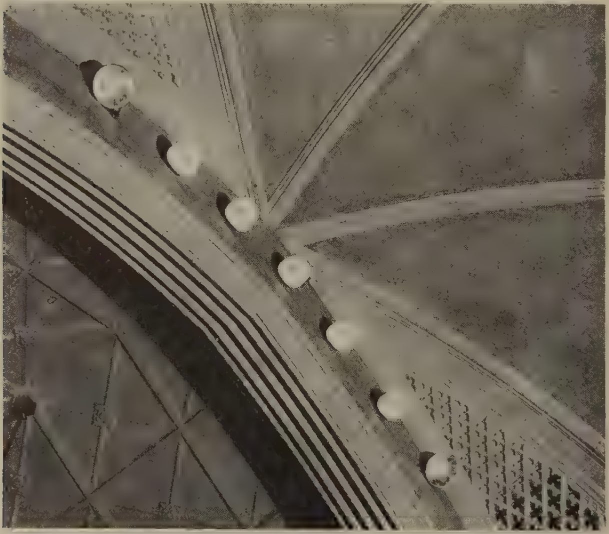


FIGURE 176—Looking upward, a view of reflectors installed behind a chancel arch to provide reading light for the choir and a means of accentuating the sanctuary space.

Questions of utility enter more definitely into the lighting of the spaces used for social and educational purposes. Frequently the simple chapel or class rooms do not require a strictly decorative luminaire, but because of the tender years of the majority of the occupants precaution should be taken to make sure the lighting effects are restful.

In the design of the lighting for club rooms and social rooms, we should carefully consider the use to which the room is to be put, and provide a flexible system. For example, if the room is to be for entertainment, something of the character of the theatre must be provided. On the other hand, if it is to be used for a general gathering of the

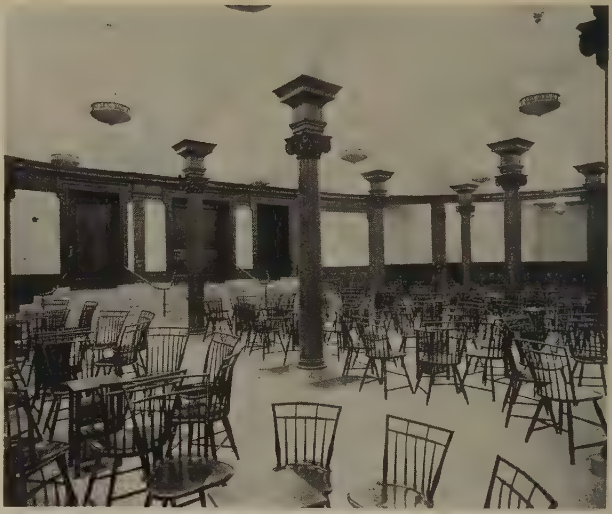


FIGURE 177—Sunday School Room, The First Church of Christ Scientist, Boston, Mass. Precautions should be taken in classrooms to provide lighting that is restful and glareless.

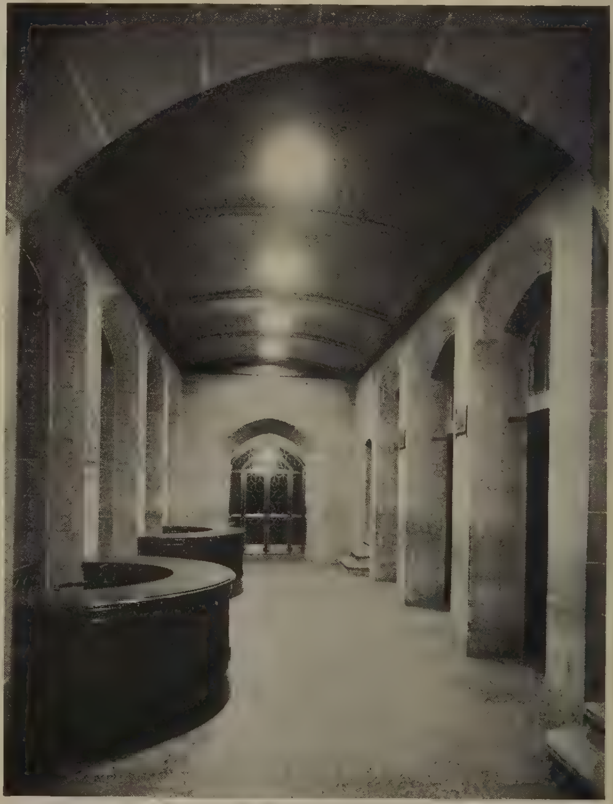


FIGURE 178—Narthex of St. Thomas Aquinas Church, Chicago. Diffusing lighting units are placed in the ceiling. A decorative rim supports the glass plate through which the light filters.

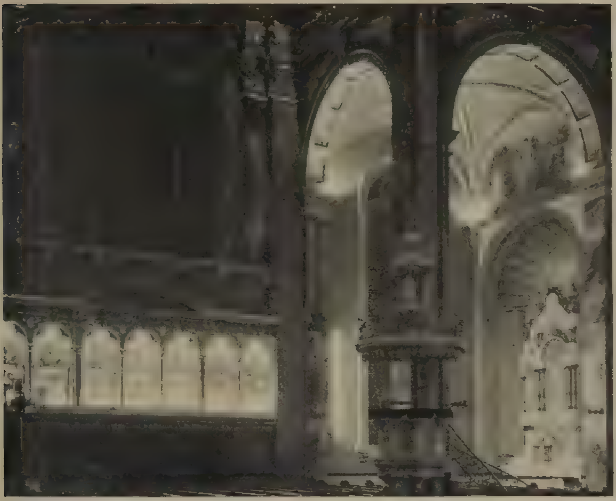


FIGURE 179—Stations of the Cross, St. Josaphat's Church, Milwaukee, Wis. Method employed is similar to that illustrated below.

church body on special occasions, it takes on the character of an assembly hall. If a church supper or social is to be held, the lighting should have decorative possibilities for such festive occasions.

For outside lanterns or niches glass should be avoided as much as possible. In the small copper lanterns that are used taking the symmetrical cylinder or glass shade, there is no objection to using glass. But where the lantern or niche is provided with a special design of grill, glass should be avoided, due to the fact that it is very difficult to replace should it happen to be broken.

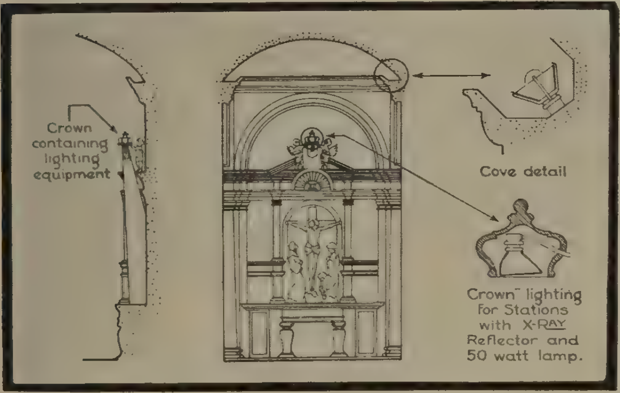

Crown containing lighting equipment
Cove detail
Crown lighting for Stations with X-RAY Reflector and 50 watt lamp.

FIGURE 180—Sketch giving a section and an elevation of the Stations of the Cross in Our Lady of Victory Shrine, Lackawanna, N. Y.

Some of the richest examples of the designer's art are represented by the beautiful windows of our churches. The desirability of lighting these creations at night is not questioned. These windows may be made to shine forth the message of the church, appealing with their symbolic beauty to the spiritual nature of the passerby. The churches of the country should use this medium to a much greater extent. A capital of at least $25,000,000 is invested at the present time in stained glass windows. These are seen only a few hours on Sunday.

Effective lighting methods will reveal the beauty of these windows, whether they be seen from the street or by those inside the church attending services. Various methods have been employed, depending upon the architectural conditions to be encountered. The window shown in Fig. 181 is very effectively illuminated by the use of a simple commercial type of floodlight, such as illustrated on page 301. The units are placed at inconspicuous locations within the auditorium. Frequently rows of reflector units, concentrating the light upon the window, are mounted upon beams so as to be hidden from view.

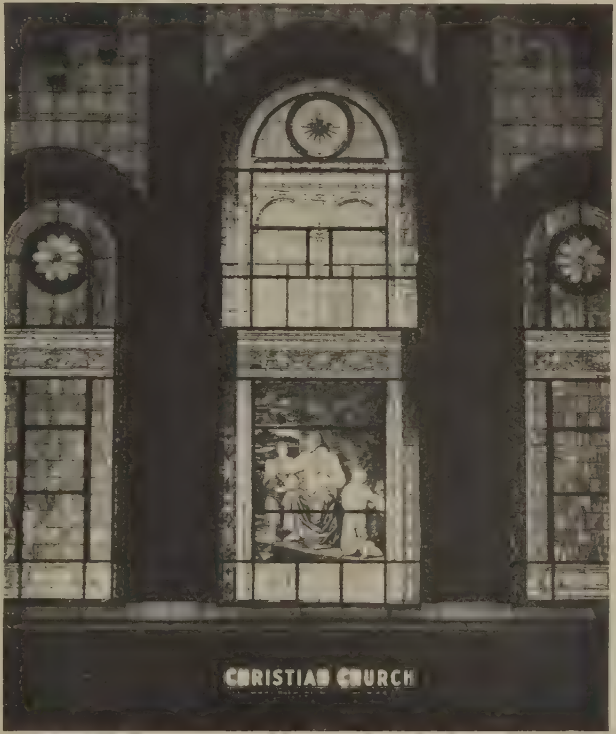
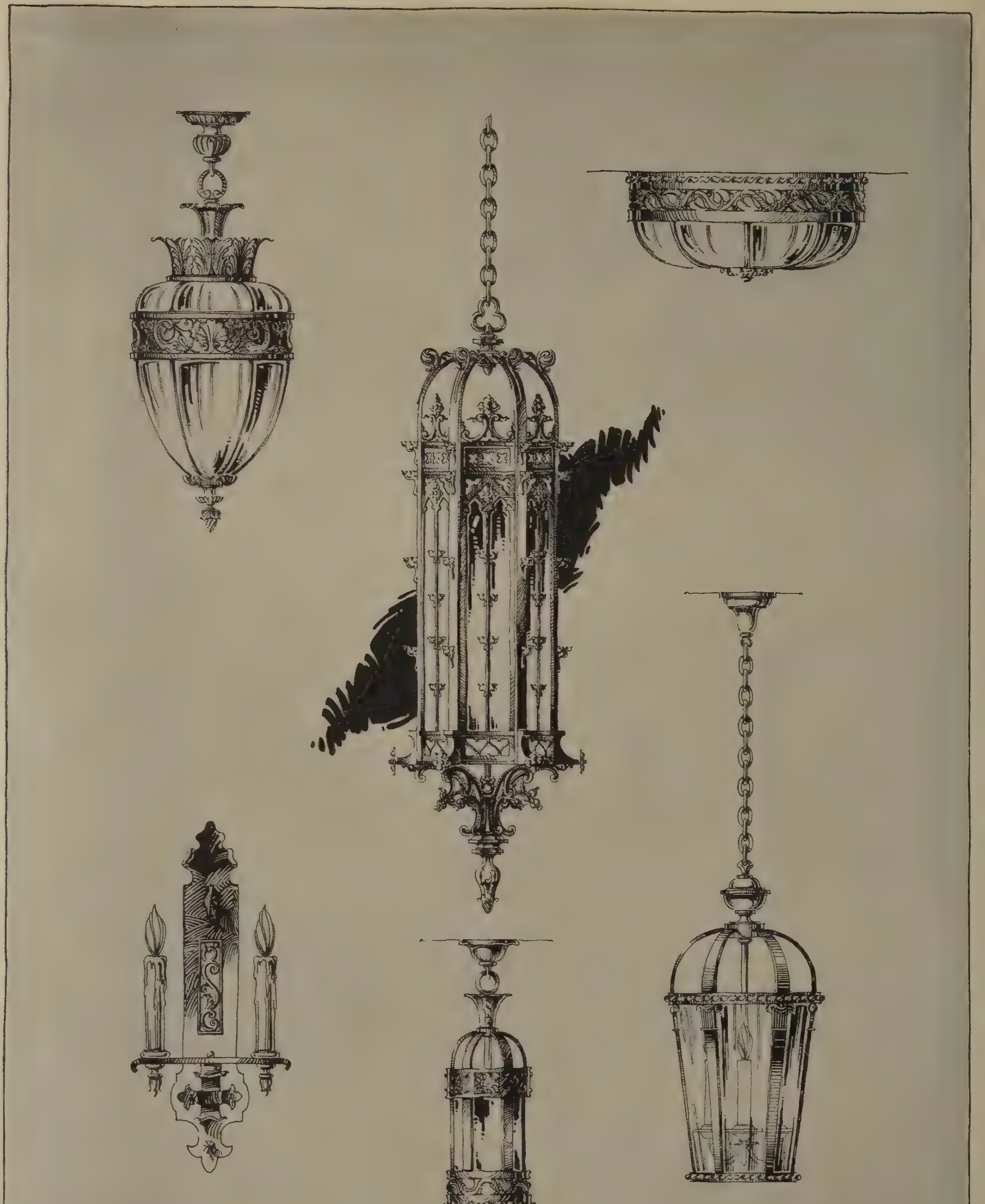
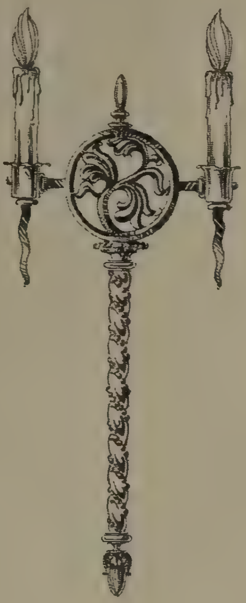
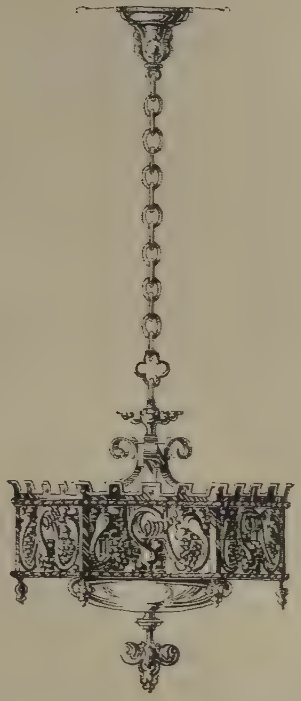
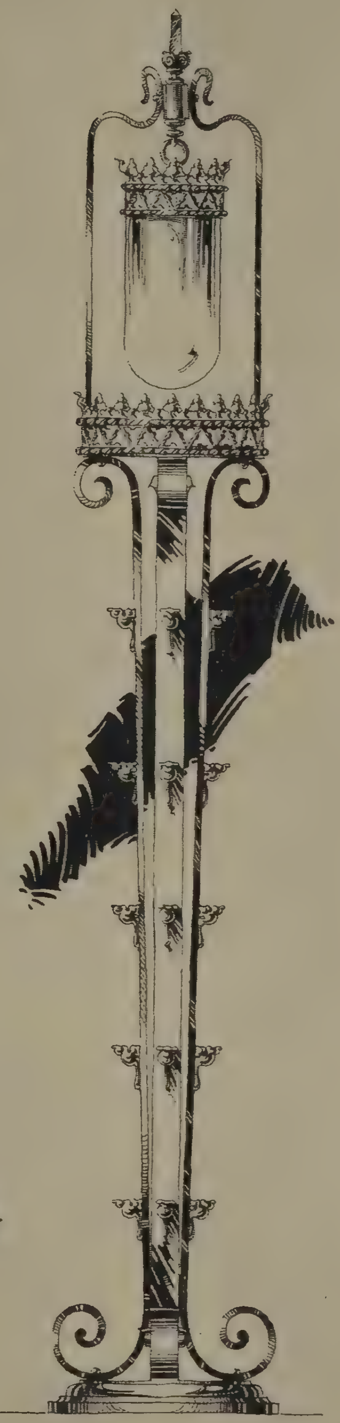


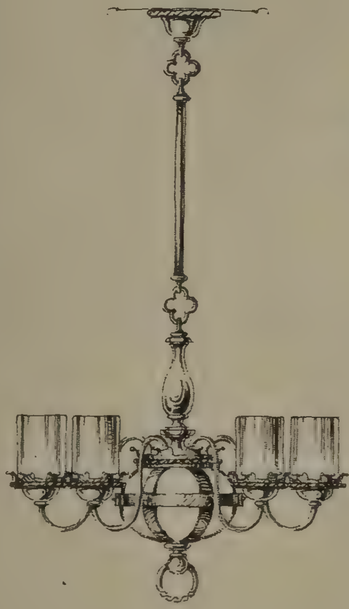
FIGURE 181—Art glass window, St. Matthew's Christian Church, Norwood, Ohio. Kunz & Beck, Architects, Cincinnati. A lighted window that has a spiritual message for the passerby.

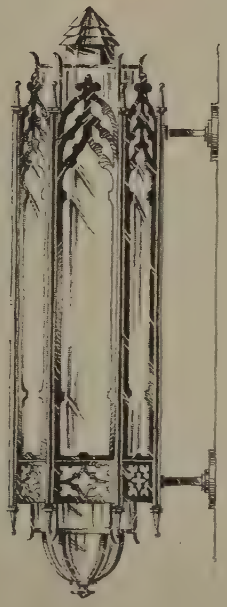












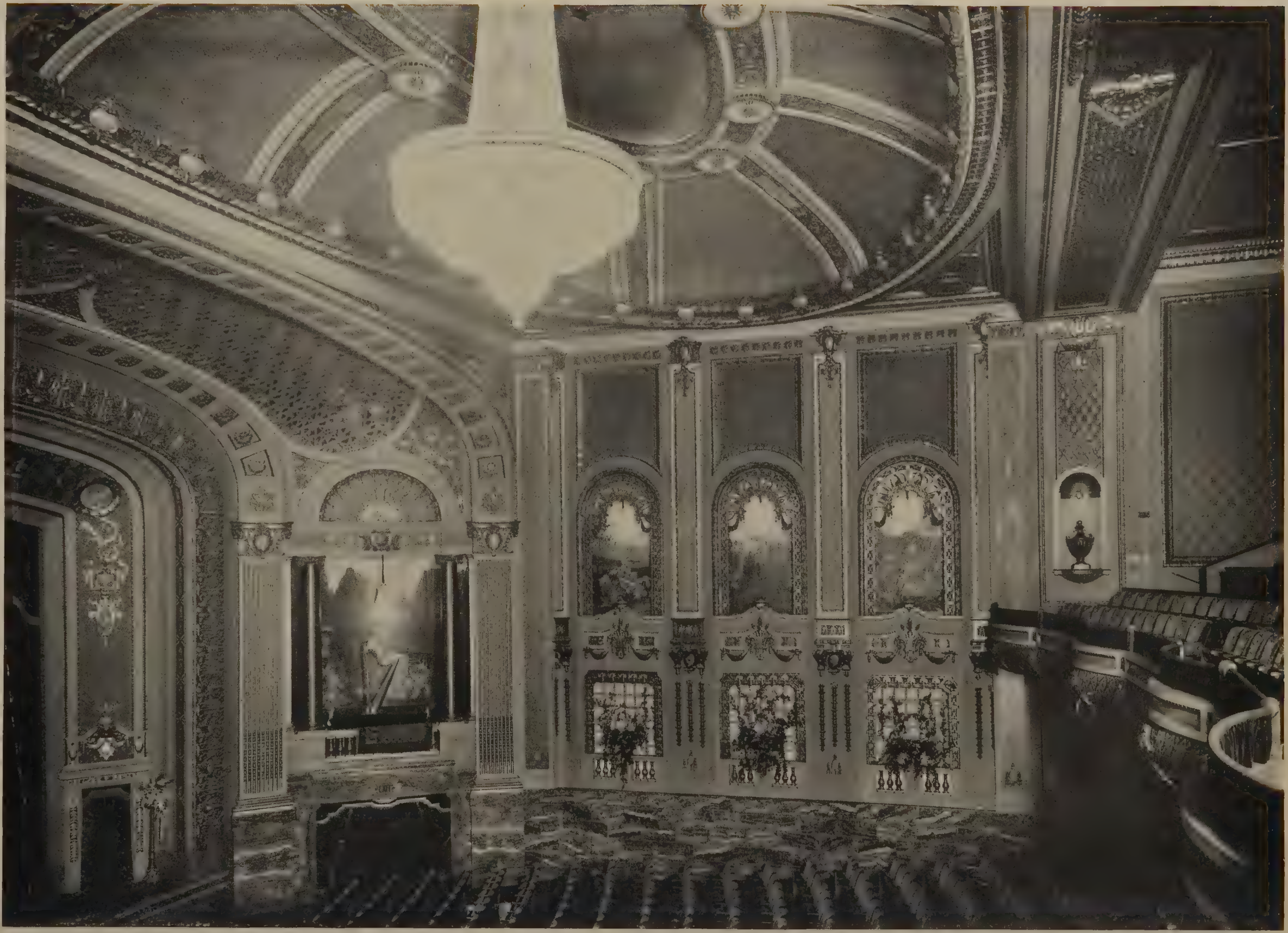
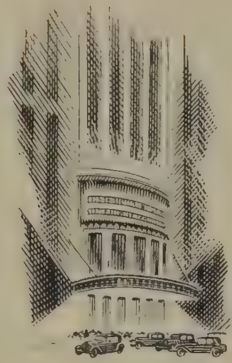


FIGURE 182—The auditorium of the Byrd Theatre, Richmond, Va. Fred A. Bishop, Architect. The luminaires of crystal and bronze especially designed for this theatre, add a touch of unusual beauty and give practical lighting results from the X-Ray reflectors contained within them.



THEATRES

IT WAS not until the Renaissance that artificial lighting was introduced for the illumination of plays. We remember that the Greeks and Romans, and the poor, shambling players of the Middle Ages gave all of their performances in open air in broad daylight. When the theatre forsook the sunlight and came indoors, it faced the problem of artificial lighting. By means of torches, tapers, gas and, finally, electricity, it has made its art visible indoors and at night.

Even the smallest playhouse, that is deprived of the most simple mechanical conveniences, with a cramped stage, can still achieve visual beauty through light. Mr. Irving Pischel says that this force brings to the playhouse the most subtle and affecting gift of the physical world, barring only the human presence.

The theatre of today is primarily an artificially lighted interior. Lighting, therefore, is of the very greatest importance. Theatres have been known to exist without stages, without seats, without scenery, and even without actors; but lighting, either artificial or natural, is obviously indispensable to the theatre. Of the two senses which function at a play, sight and hearing, sight is by far the most important; and light and color are the strongest tools of modern stagecraft.

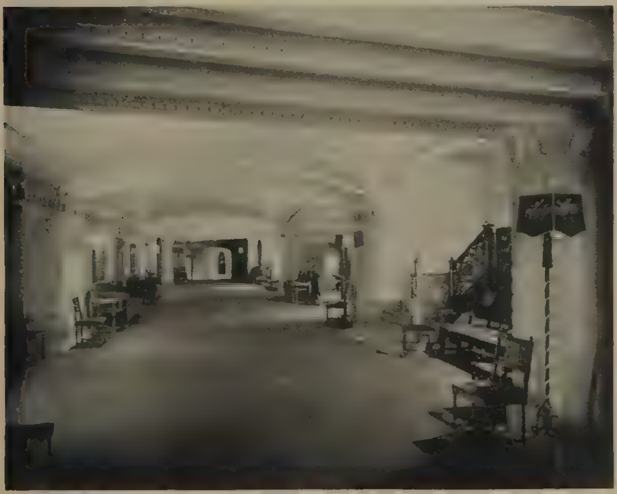


FIGURE 183—Lobby of the Granada Theatre, San Francisco, Cal. Appropriate lighting is supplied by indirect portable lamps. Obviously, ceiling luminaires would not be advisable.

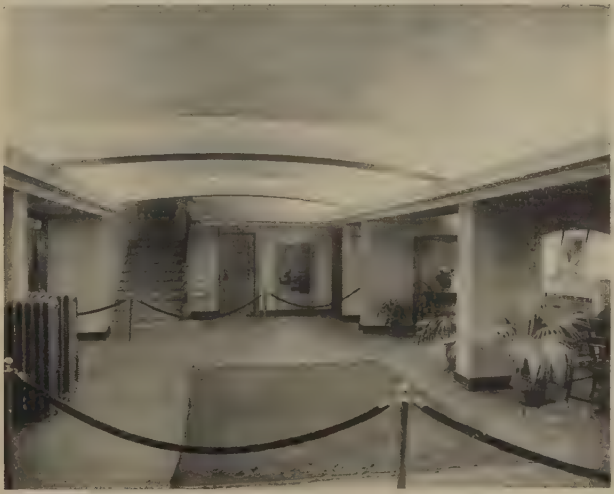


FIGURE 184—Cove lighting in a low ceilinged lobby in a motion picture theatre. Lack of head room and the presence of large cornices ledges suggest concealed lighting.

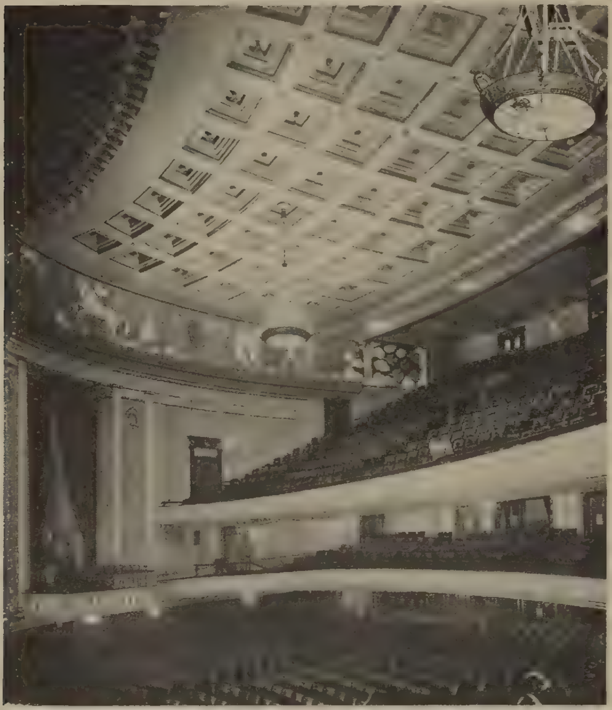


FIGURE 185—The architect of this theatre demanded that a luminaire be designed in strict fidelity to the pure Greek period of the ornament and yet give pleasing and practical results.

The Lobby

Except for the exterior of the building, which is usually ablaze with a large electrical advertising sign and other brilliant lighting effects, the foyer, or lobby, is the first to be considered in the planning of theatre illumination. Here the most intense lighting for the entire theatre is found.

One of the fundamental points to keep in mind in planning theatre lighting is that the whole illumination scheme should be arranged so that a suitable transition in brightness is afforded in passing from the street through the entrance and lobby into the dimly lighted auditorium. The visual shocks that come with sudden changes of intensity will be practically eliminated if this principle is carefully applied. The eye thus becomes accustomed to the darkened surroundings.

Where lamps are used on side wall brackets, and are installed about the eye level, some artistic means of shading should be employed, especially in houses where the public is obliged to wait for an opportunity to enter the auditorium.

The Auditorium

The auditorium offers the architect, theatrical producer and illuminating engineer an opportunity for the use of their ingenuity in the applying of novel and spectacular effects. Those responsible have in the handling of light a wonderful power for advertising effect, and for the comfort

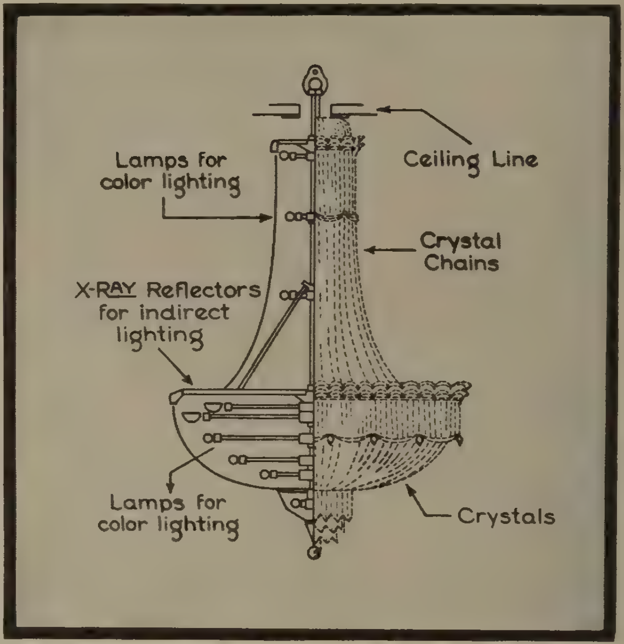


FIGURE 186—A theatre showing mechanical construction of the bronze and crystal chandelier used in the auditorium of the Byrd Theatre pictured in Fig. 182.

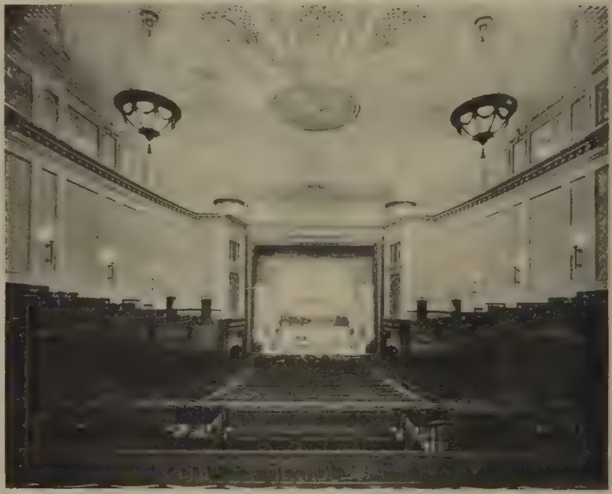


FIGURE 187—The Auditorium Theatre, Dayton, Ohio. Pretzinger and Musselman, Architects. The large luminous indirect fixtures embody in their construction arrangements for color changes.

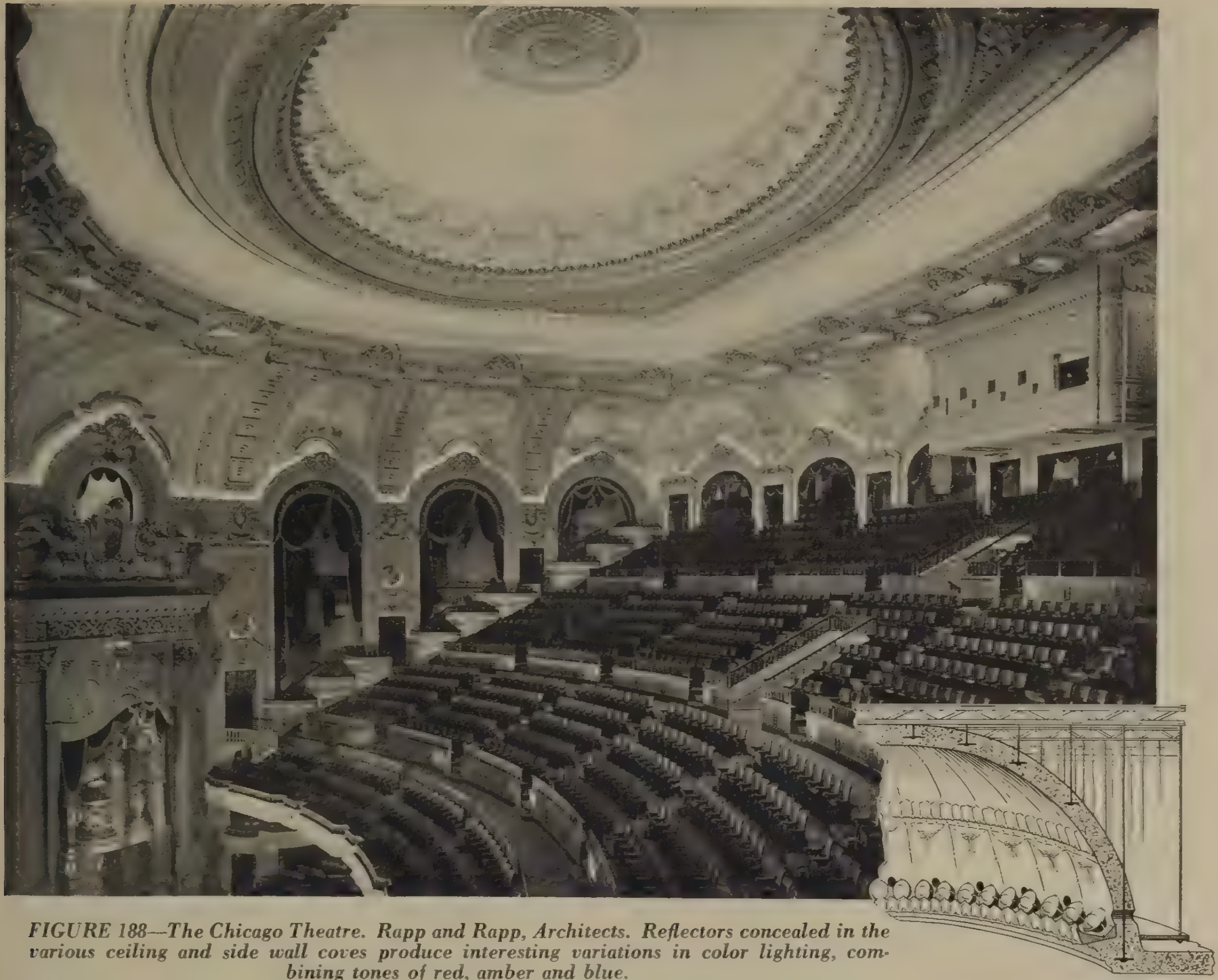


FIGURE 188—The Chicago Theatre. Rapp and Rapp, Architects. Reflectors concealed in the various ceiling and side wall coves produce interesting variations in color lighting, combining tones of red, amber and blue.

of the patrons. The indirect lighting system has been generally adopted for theatre lighting, with variations as to color effects and decorative touches, as well as controllable gradations of intensity. These may be accomplished by means of hanging fixtures, lights hidden in cornices, on pedestals, brackets, etc., depending on the personal taste of the owner and the architectural influence of the interior. Modern cove lighting especially is very advantageous for use in the motion picture theatre where "talkies" are presented. The breaking up of the wall and ceiling surfaces by the structural elements containing the lamps and reflectors assists greatly in obtaining the most favorable acoustical conditions.

In the auditorium obviously there should be no bright light sources. They are disturbing to vision and interfere greatly with the clearness of the pictures on the screen, especially in the movie theatres. An adequate amount of illumination should be available at all times to enable the patrons to easily locate seats, thus eliminating mistakes and accidents. All stair landings and aisles should be equipped with some type of indication light. The emergency system for the auditorium is, of course, separate and distinct from the general lighting, but should be designed to conform with the regulations of the particular city in which the playhouse is situated.

As an example of the extent to which the theatre owner and producer may incorporate color lighting effects in the auditorium, Fig. 188 is given. It shows the balcony view of the Chicago Theatre, designed by Rapp & Rapp, architects.

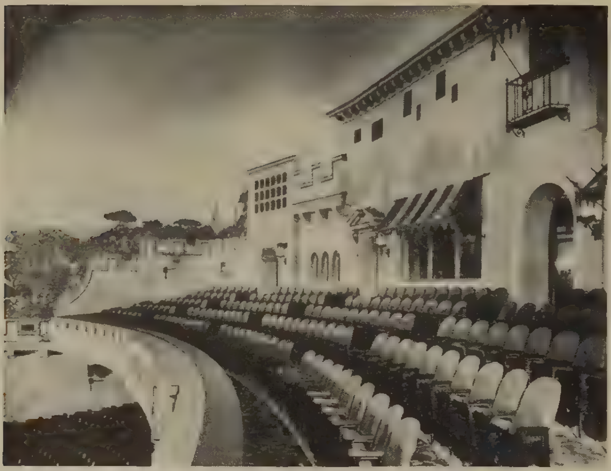


FIGURE 189—The Capital Theatre, Saskatoon, Sask. J. Murray Brown, of Toronto, Canada, was the architect, with Mr. D. Webster as associate. A "movie" theatre of the "atmospheric" type, with the "sky" illuminated in subdued values of blue.

The great suspended ceiling and dome incorporate a series of coves, in which special reflectors have been installed, with red, amber and blue colors. A complete cycle of color changes is a definite part of the program of entertainment, and is usually planned for the period when the overture is played by the orchestra. The theatre of the future will, without doubt, utilize harmonious lighting effects in all of its presentations.

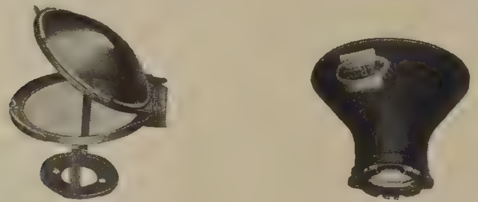


FIGURE 190—X-Ray reflector and color lens equipment, such as used for tinted lighting in theatres.

The means for doing this are now available to the exhibitors. A system of dimmers in circuit with the lighting units provides an easy method by which the auditorium may be lighted so gradually that one scarcely is aware of the increasing intensity.

Theatres of pure architectural design require the most careful treatment in their lighting. The style, relative proportions, material and finish of the luminaires all have an important bearing upon the general harmony of the interior. The design of a modern luminaire is considered to be more than an artistic arrangement of ornamental elements. It must be correct traditionally, and also must have a real lighting purpose.

In the case of the theatre shown in Fig. 185 the condition imposed upon the lighting man was that of providing equipment to give a definite quality of illumination housed in a fixture of design having fidelity to period. The spirit of the entire building is Greek-Roman. The luminaire for the theatre auditorium properly resembles an old Grecian urn, supported in a bronze frame with rounded arms. The color combination is Etruscan green and terra cotta. Two of these large fixtures were required for the lighting of the auditorium. Each contains twenty-four 200-watt lamps in X-Ray reflectors, over the mouth of which are colored plates of heat-resisting glass.

In the theatre pictured in Fig. 182, all of the principal lighting for the auditorium, with the exception of the balcony sections, comes from a large crystal fixture, the details of which are

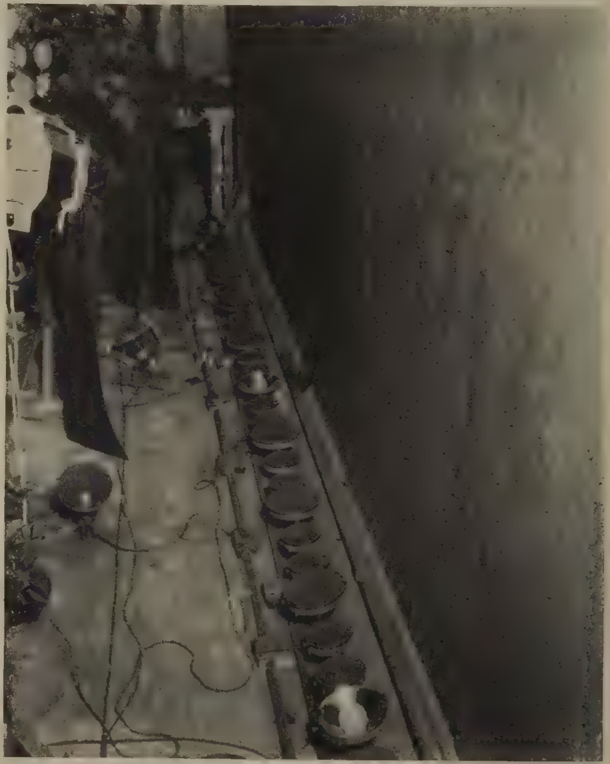


FIGURE 191—The National Theatre, of Milwaukee, Wis. Dick & Bauer, Architects. X-Ray reflectors and color accessories for blue sky or "atmospheric" effects are installed as illustrated here.

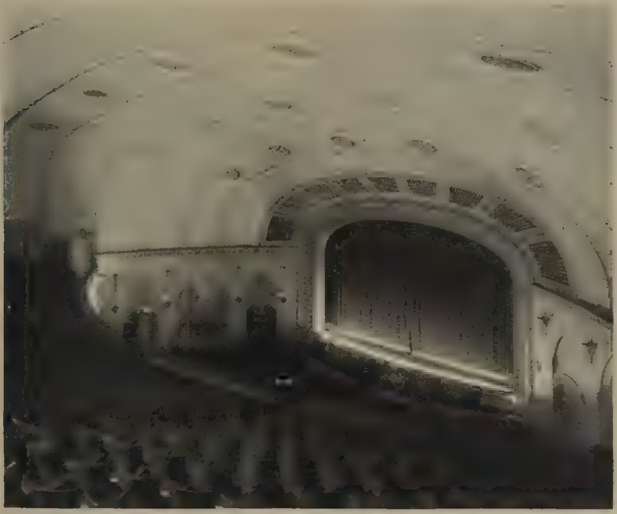


FIGURE 192—The Goodyear Theatre, Akron, Ohio. Reflectors are hidden in the front of the balcony rail. See detail below.

shown in Fig. 186. This fixture measures 12 feet in diameter and 16 feet in height. The wiring is arranged on 20 circuits and serves 400 lamps, consisting of indirect reflecting devices with color attachments recessed in the interior of the fixture body. The combining of the artist's skill and practical features of illumination in a luminaire of this character is somewhat of a departure, and has resulted in a lighting unit that has all the beauty of the old time crystal chandelier, to which is added an infinite variety in color effects.

The theatre shown in Fig. 189 is of the so-called "atmospheric" type, having a "sky" illuminated in subdued values, preferably in blue, by means of equipment entirely concealed from view. The theatre auditorium is designed so that the lighting is accomplished from fifteen or twenty short coves. The total length of these coves averages about 250 feet, for which special X-Ray reflectors, of the type shown in Fig. 190, are employed. The "atmosphere" effect is obtained more advantageously by using the permanent color lenses, illustrated and further described on page 285. A typical method of installing equipment of this character for the production of the atmospheric effect is shown in Fig. 191. For average conditions the application of cove lighting is not especially difficult, but in rooms of this character, where an even spread of light is desired upon the ceiling, and where the locations for equipment come at irregular intervals, very careful planning must be resorted to.

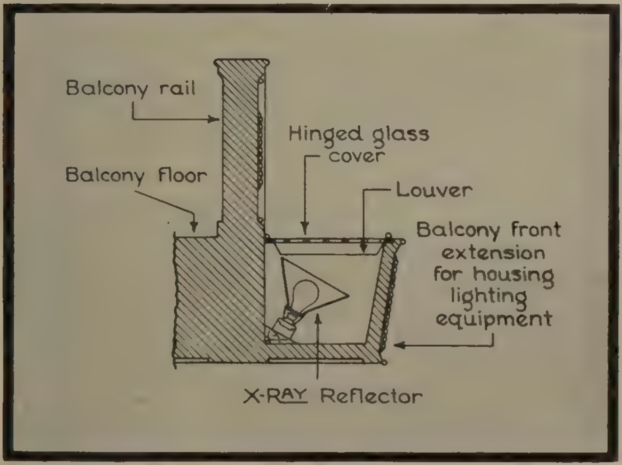


FIGURE 193—An extension to the balcony rail provides space for lamps and reflectors for novel lighting effects.

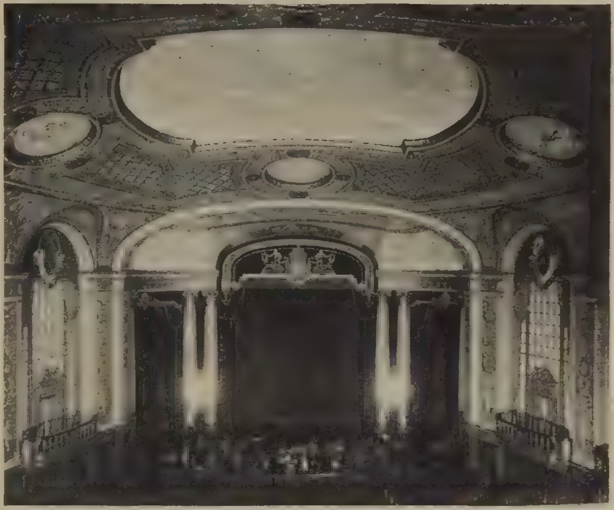


FIGURE 194—The Allen Theatre, Cleveland, Ohio. Through the false windows at each side of the auditorium a soft glow emanates. It is produced by X-Ray reflectors and lamps placed in a space recessed in the wall.

Soon after the introduction of indirect lighting for theatres, other methods than suspended fixtures were experimented with, and one of those which offers interesting possibilities is shown in Fig. 192. This view indicates that considerable ingenuity has been used in the concealing of lamps and reflector equipment along the front of the balcony rail. To those seated in the balcony no lamps are visible, and yet the auditorium is flooded with diffused illumination. When viewing the balcony from the stage it is not at once apparent that the structural compartment has been added, so well does it fit into the architectural design of the auditorium.

Frequently, to avoid montony in the general aspect of the auditorium, unusual features are incorporated in the design. For example, in Fig. 194, the side walls of the room are built to simulate large arched windows. The framing is covered with silk, and behind what would be the glass area is concealed a series of reflectors, casting their light upon the painted wall surface of the recess. The result is a well diffused illumination over the entire surface of the window panel. As the play progresses there may be an accompaniment of changing lights, one color blending into another.

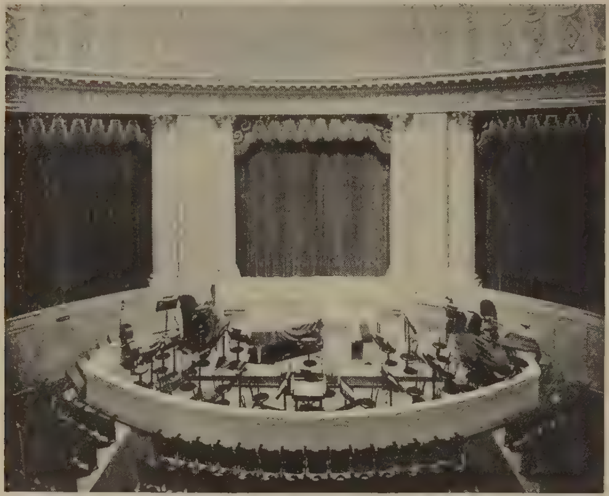


FIGURE 195—The light concentrated upon the orchestra comes from equipment concealed in spaces provided in the ceiling.

The Orchestra

Many of the large theatres are providing special arrangements whereby the flood of light may be concentrated upon the orchestra during the overture or other special musical numbers. With the auditorium light subdued, the musicians are revealed in bold contrast to the surroundings, tending to keep the attention of the audience upon the musical number. Examples of orchestra pits lighted in this manner are shown in Figs. 195 and 196. The methods for producing this concentration are various. Frequently projectors are concealed above the ceiling, the light beams coming through an opening. When the orchestra pit is well back under the proscenium arch the units may be placed among the borders. For the example shown in Fig. 196 it was the desire of the theatre owners and architect to confine the light, as nearly as possible, to the orchestra pit area, also to secure lighting having the proper directional effect and conceal, as thoroughly as possible, the equipment that produced the illumination. The sketch shown in Fig. 197 shows how the lighting was accomplished in this particular instance. It may be noted that two principal locations are used. Just back of the proscenium arch several 500-watt flood lighting units, especially equipped, were installed, and in the balcony front, at each of the five locations, two 250-watt projectors of special design were placed,

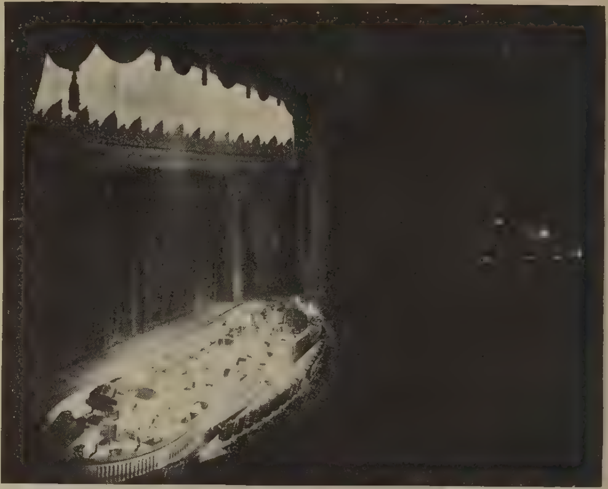


FIGURE 196—The orchestra pit may be provided with vertical lighting from above, and a horizontal component from units concealed in front of the balcony.

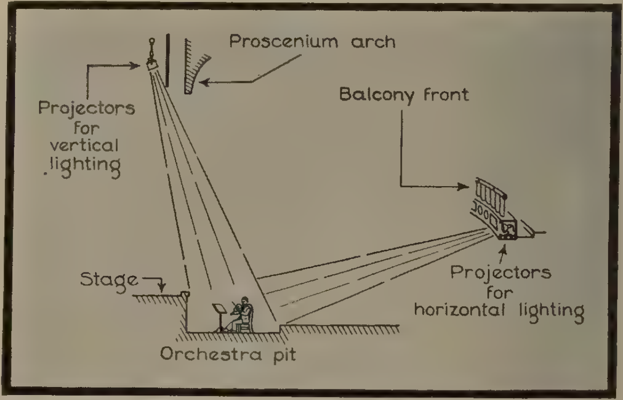

Proscenium arch
Balcony front
Projectors for vertical lighting
Stage
Projectors for horizontal lighting
Orchestra pit

FIGURE 197—Diagram showing the method of accomplishing the lighting of the orchestra pit shown in Figure 196.

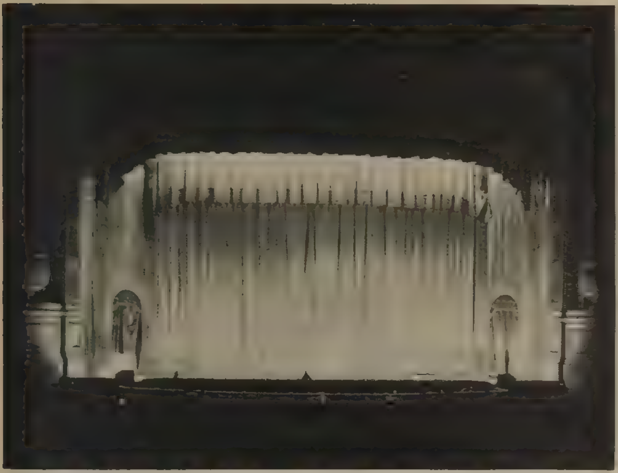


FIGURE 198—General view of typical stage showing proper lighting effect from overhead borders and side proscenium strips and footlights. All equipped with X-Ray reflectors.

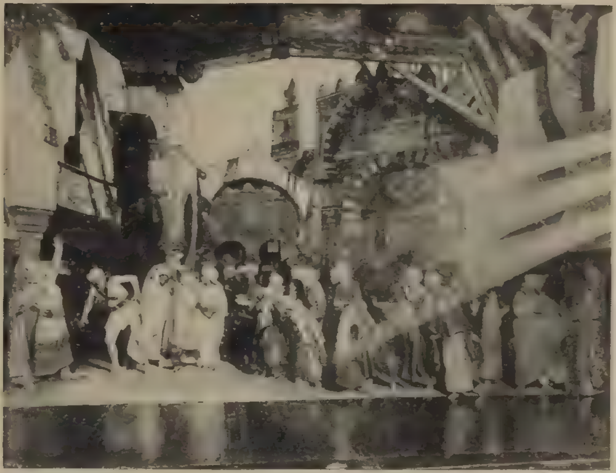


FIGURE 200—A scene in the production of "Mecca," showing the effect of the so-called "Sun Truck" made up of X-Ray light projector devices.

thus providing both a horizontal and a vertical lighting for the orchestra.

The Stage

Since the development of the incandescent lamp, an entirely new art of stage lighting has been evolved. The present stage productions and stupendous spectacles would not have been possible in the days of the flickering candles and gas jets with their variable intensity, low candle power and lack of flexibility. The old stage borders and footlights consisted merely of a metal trough containing a series of lamps. These were not effective in the utilization of the light. The losses in control and quantity of light with the old types were enormous. With the development of the new art in stage lighting, each lamp has its own reflector. This has brought efficiency into stage lighting because it is scientifically based upon the principles of light control. It puts the lighting of the stage on a rational and more economical basis. The illumination of the stage by direct reflection, with its exact control of light, has been a step in the right di-

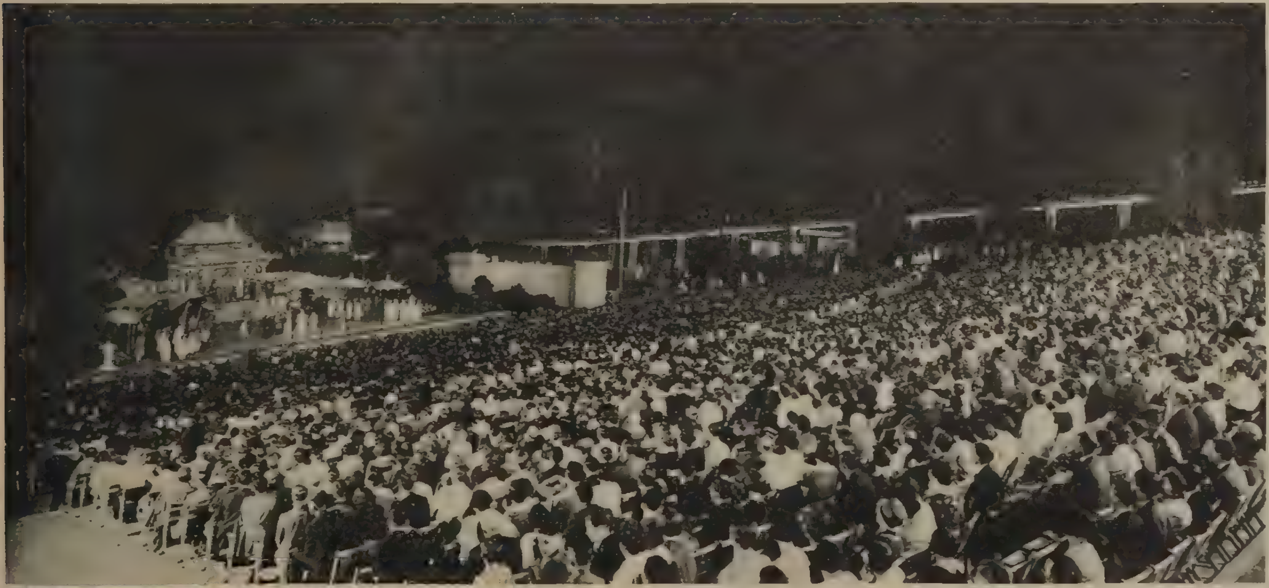


FIGURE 199—The outdoor auditorium of the Municipal Opera, St. Louis, Mo. This popular summer theatre involves several special lighting problems for both the audience and the stage. Shrubbery and pergolas were utilized for the concealment and mounting of X-Ray reflector equipment, with most pleasing results.

rection as against the old borders and foots, whose rays were unconfined.

A view of a typical stage lighted by this new type of equipment is shown in Fig. 198, and the equipment to produce the effects is shown on the pages following. It will be noted that borders, footlights and proscenium strips all contain reflectors for each individual lamp, enabling the producer to direct the light where it will be most effective. In many installations of the old type borders too much light was thrown against the back wall or on other locations of the setting. Control of the light by the proper use of individual concentrating and diffusing reflectors tends to a more natural distribution.

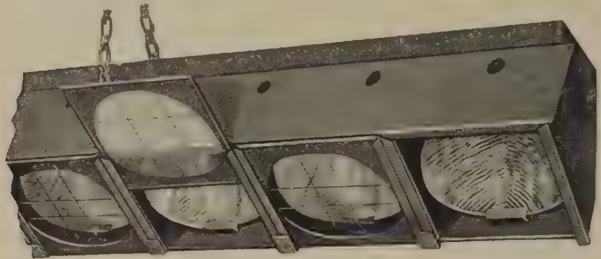


FIGURE 201—Details of typical Curtis Lighting stage border unit.

Complete installations of X-Ray stage lighting equipment, including borders, footlights and strips, are shown in Figs. 202 and 203. All X-Ray stage equipment utilizes large, powerful incandescent lamps, and is so designed that a perfect control of light is possible, thereby reducing the amount of wattage that would ordinarily be required for illumination of the stage. Color effects for the footlights and strips are obtained by means of special lenses of heat-resisting quality, so that it is unnecessary to use dipped lamps or other color accessories. The color lens furnishes a permanent and constant medium for producing the lighting effects required on the stage.

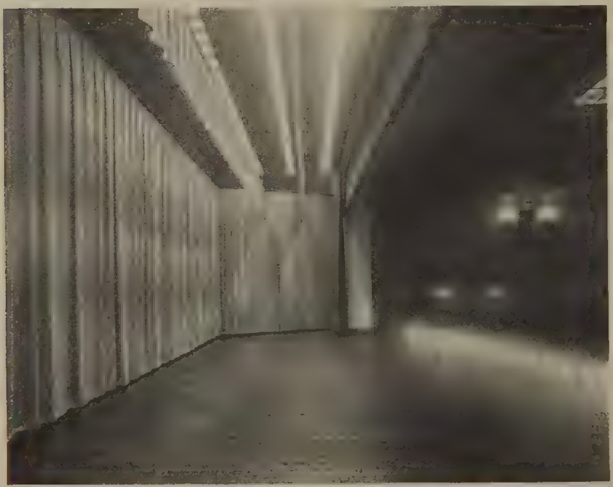


FIGURE 202—Stage of the City College Auditorium, Baltimore, Maryland. Footlights are of the disappearing type, such as shown in Figure 207. Border lights have individual X-Ray reflectors for each lamp.

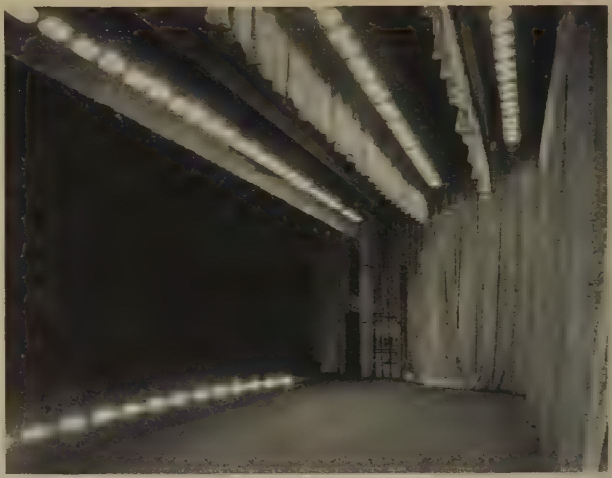


FIGURE 203—Stage of the Ivanhoe Masonic Temple, Kansas City, Missouri. A typical and adequate arrangement for stages of fraternal organizations.

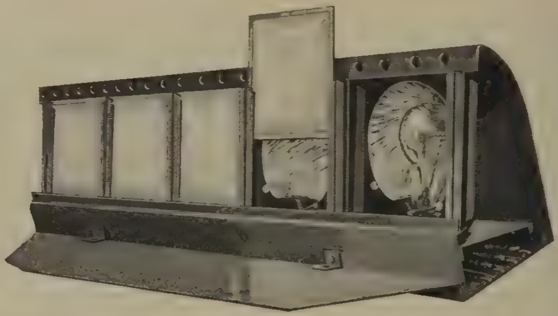


FIGURE 204—Detail of typical footlight for theatres using X-Ray reflectors.

The architect is frequently called upon to provide stage equipment for schools, community playhouses and lodge halls. When these small assembly halls are used as auditoriums, it is often desired to have available a type of footlight equipment which can be made to disappear when not employed for plays and other productions. Frequently the room is used as a lecture hall, in which

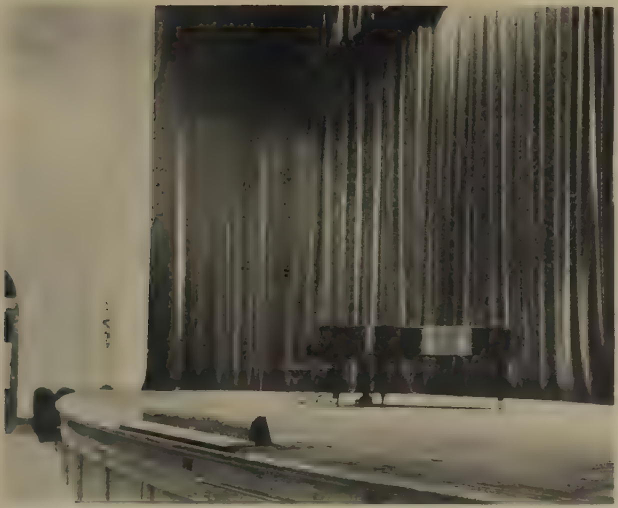


FIGURE 205—Western Hills High School Auditorium, Cincinnati. Close-up view of X-Ray disappearing footlights. One section only is shown in operating position.

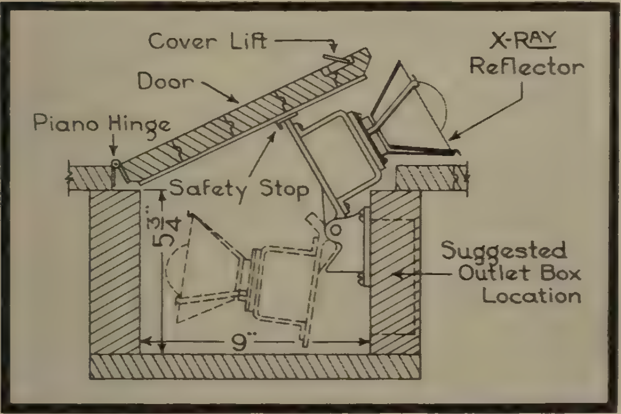

Cover Lift
X-RAY Reflector
Door
Piano Hinge
Safety Stop
5¾"
Suggested Outlet Box Location
9"

FIGURE 206—Disappearing type footlight for small stages.

case it is undesirable to have the footlights. For general assemblies and other occasions footlights are not needed, and if permanently installed would probably obstruct the level surface of the stage floor. In some cases a portable or movable type of footlight may be employed; but where conditions will permit, a disappearing type is most desirable, as shown in Figs. 206 and 207. It will be noted in the first case that the footlight equipment consists of a series of small reflectors mounted on a wiring channel of CurtiStrip, which contains all of the circuits that feed the lamps. A trench or compartment into which the reflectors are lowered is closed by a hinged pit cover. A catch forms the means of supporting the pit cover in position when the footlights are in operation. The complete line of reflectors and wiring channel is fastened by means of brackets to the pit wall. The operation of this device is evident from inspection of the sketch in Fig. 206, which shows the footlights in the working position; the dotted lines indicate how the reflectors may be hidden from view below the stage floor when not in use.

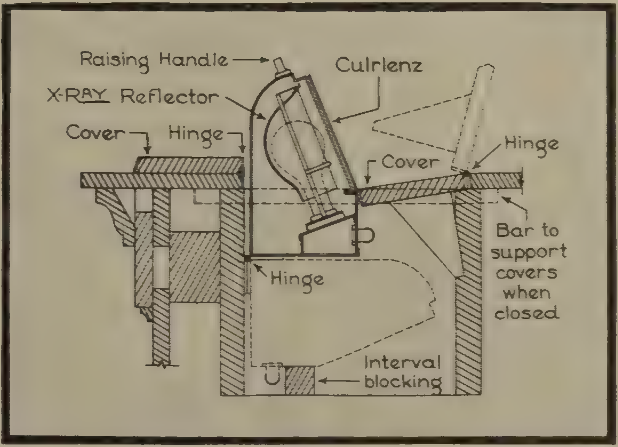

Raising Handle
Culrlenz
X-RAY Reflector
Cover
Hinge
Cover
Hinge
Bar to support covers when closed
Hinge
Interval blocking

FIGURE 207—Suggested method for installing X-Ray footlights so that they may be lowered below the stage floor when not in use.

Shown in Fig. 207 is a larger type of footlight, and the practical installation of this particular type of equipment is pictured in Fig. 205, where only one operating section is shown in position, all others are below the stage floor. The smaller footlight is shown below in practical use.

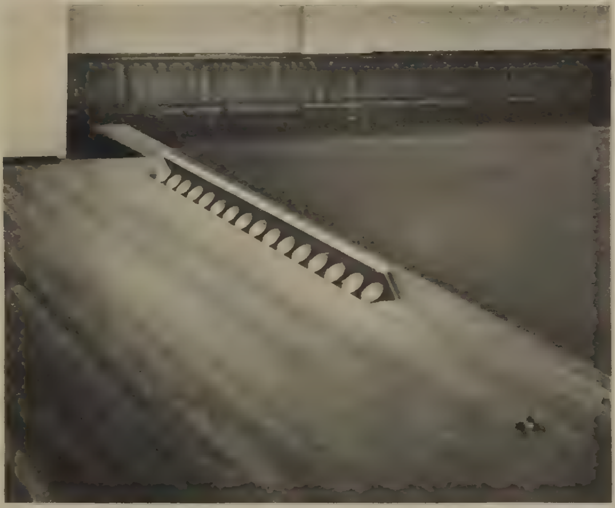


FIGURE 208—Disappearing footlights in K. of C. Building, Indianapolis, Indiana. See details in Figure 206.

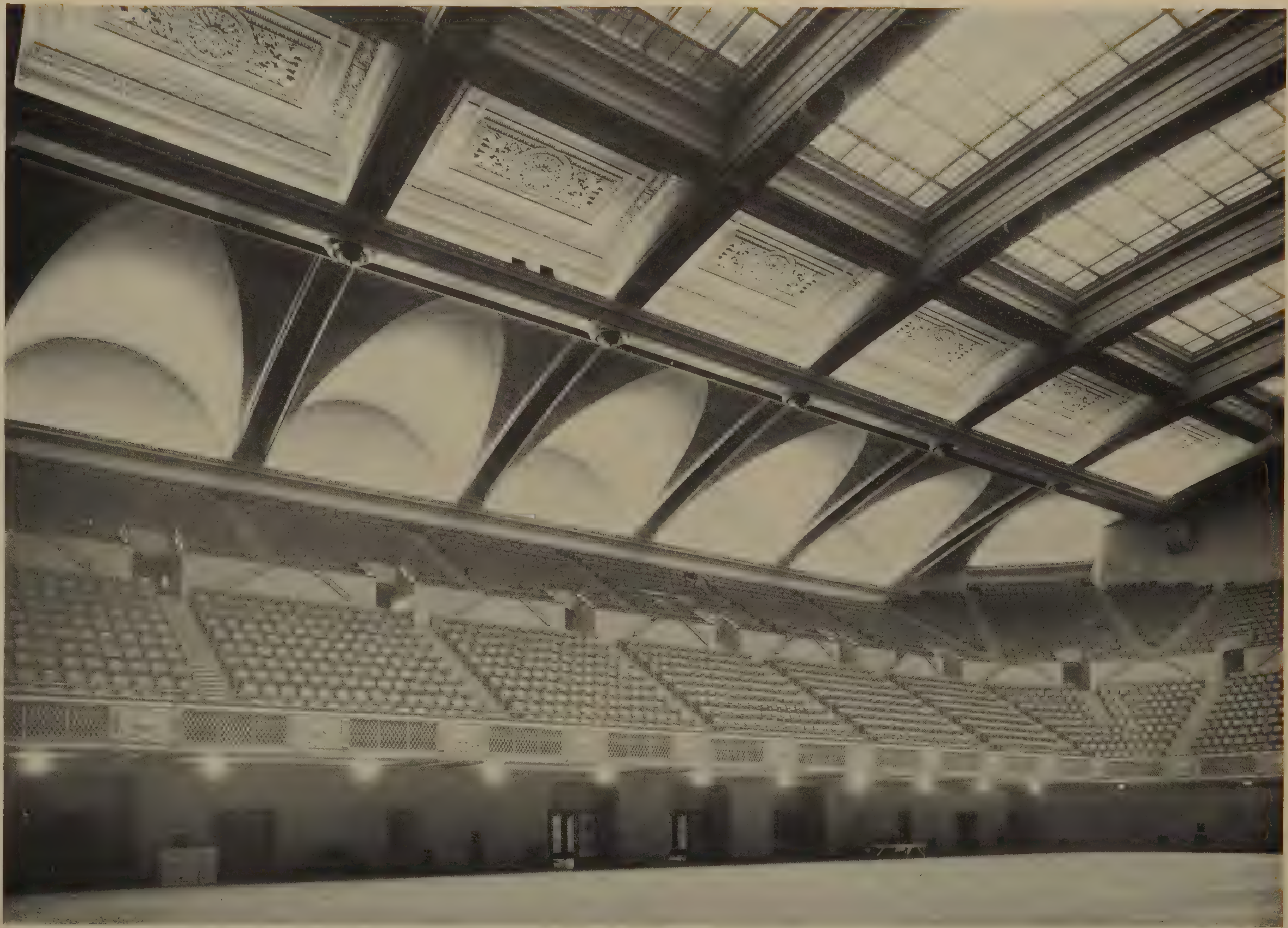


FIGURE 209—The Municipal Auditorium, Minneapolis, Minn. Croft & Boerner, Architects. This type of lighting, with an absence of pendant fixtures, adds dignity to this monumental municipal structure.

PUBLIC ASSEMBLY

SEVERAL important characteristics distinguish the human being from other members of the great animal creation. One of them is the fact that he is fundamentally a social individual. Even our most ancient ancestors had many things in common. Men from the earliest times have shown a strong tendency to gather together. They sat around the camp fire to appoint the chief of the tribe, and construct, even in a crude way, a set of rules for the conduct of the tribesmen. At other times they no doubt gathered in the shade of a wood to wonder at those members of the tribe who were talented in the arts of song and dance.

Our present existence is comparatively complex, but we cannot escape these fundamentals, this tendency and need for meeting with our fellow beings to discuss our common problems or to be entertained and instructed. Through long generations the tendency of men to gather together has caused special types of buildings to be developed. The need for specialization in the government of the peoples has brought about our legislative halls and assembly rooms. A higher type of mental development and greater appreciation of the beautiful are in many ways responsible for the playhouses and theatres of today.

Places of assembly in the early days were very little used at night, but now our day has become extended beyond the hours of sunlight. Artificial lighting has released the evening for our social gatherings. In discussing the illumination for these interiors, it is agreed that to see with clearness and comfort by artificial light is a most important necessity. We know also that these assembly places should be lighted with systems that are sufficient, appropriate, convenient and agreeable, systems so designed that they will enhance, rather than detract from the architectural beauty.

The general requirements for illumination of public assembly rooms comprise a proper consideration not only for the architectural features, but also the intensity value and distribution of the light, wiring for flexibility and proper control of the system, emergency lighting and provision for easy maintenance. The emergency lighting must conform to the requirements which various cities have established concerning the amount of wattage necessary. The lighting problem is, first, one of general illumination evenly distributed throughout the entire space, so that each member of the audience is provided with comfortable reading light without distracting glare.

In a recent talk by Mr. Walter Sturrock, before the national convention of the Illuminating engineering Society, it was stated that "The illuminating sources and makeup in the handling of a public meeting such as conventions are likely to have as much to do with its success as are the hard work and heavy thinking put in on the prepara-

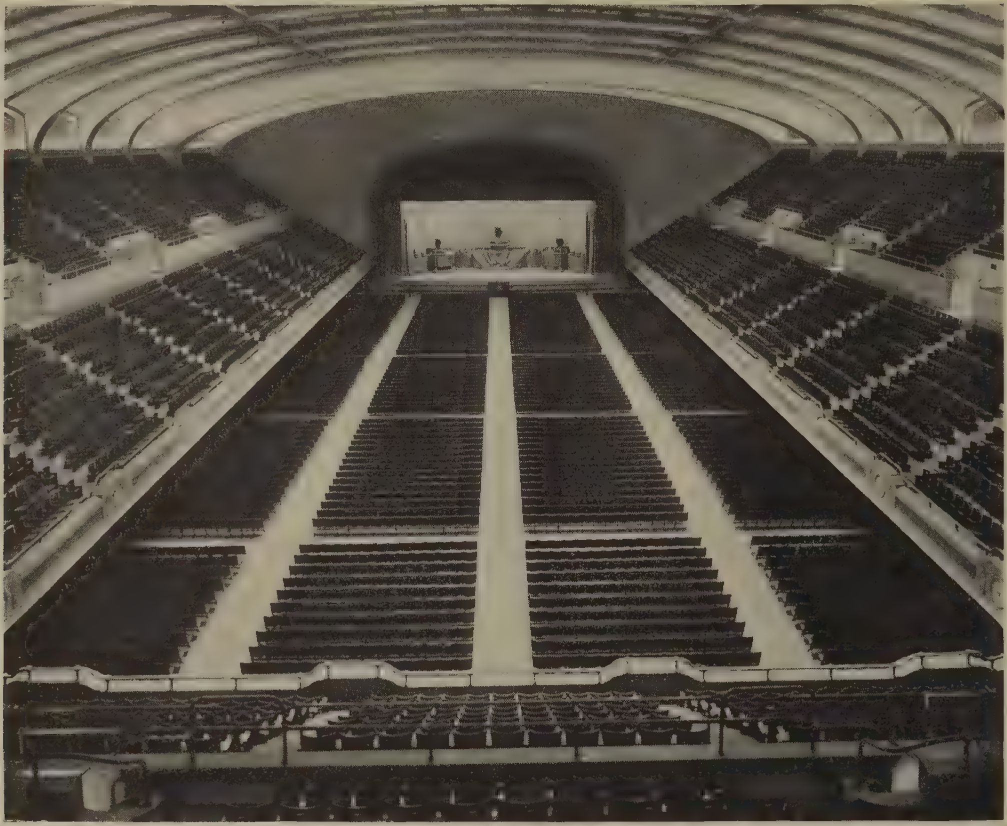


FIGURE 210—Auditorium of the Cleveland Public Hall, Cleveland, Ohio. Lighted from coves at the base of the ceiling arches, the equipment provides both white and colored illumination suitable for a large variety of public gatherings.

tion of the program, the development of good papers and the working out of advance promotion. To place any gathering or group of men into a dimly lighted, funereal chamber is to guarantee a dull and pepless meeting, no matter what may be on the program. Glaring lights are just as bad as dull, grewsome, dim lights, and in either case their existence may entirely make or break a meeting."

As a rule, public meeting places are not well lighted. Not only are glaring light sources used in the overhead systems, but in many cases side wall brackets are equipped with bare lamps, almost directly in the line of vision and more discomforting than lamps suspended from the ceiling. Many of the public meeting places are used for a number of purposes, such as dining rooms, dance halls and convention rooms. The lighting that has been planned for one is not entirely adequate or appropriate for the other. This is one of the reasons that we find such lack of harmony in the physical arrangements of public meeting places. Equipment can be installed, however, that will be sufficiently flexible to allow the room to be used for

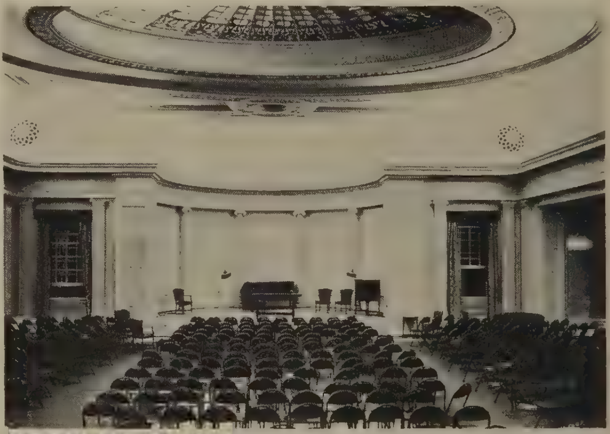


FIGURE 211—The Great Hall, Memorial Union Building, Madison, Wis. Arthur Peabody, Architect. Leon Pescheret, Consulting Decorator.

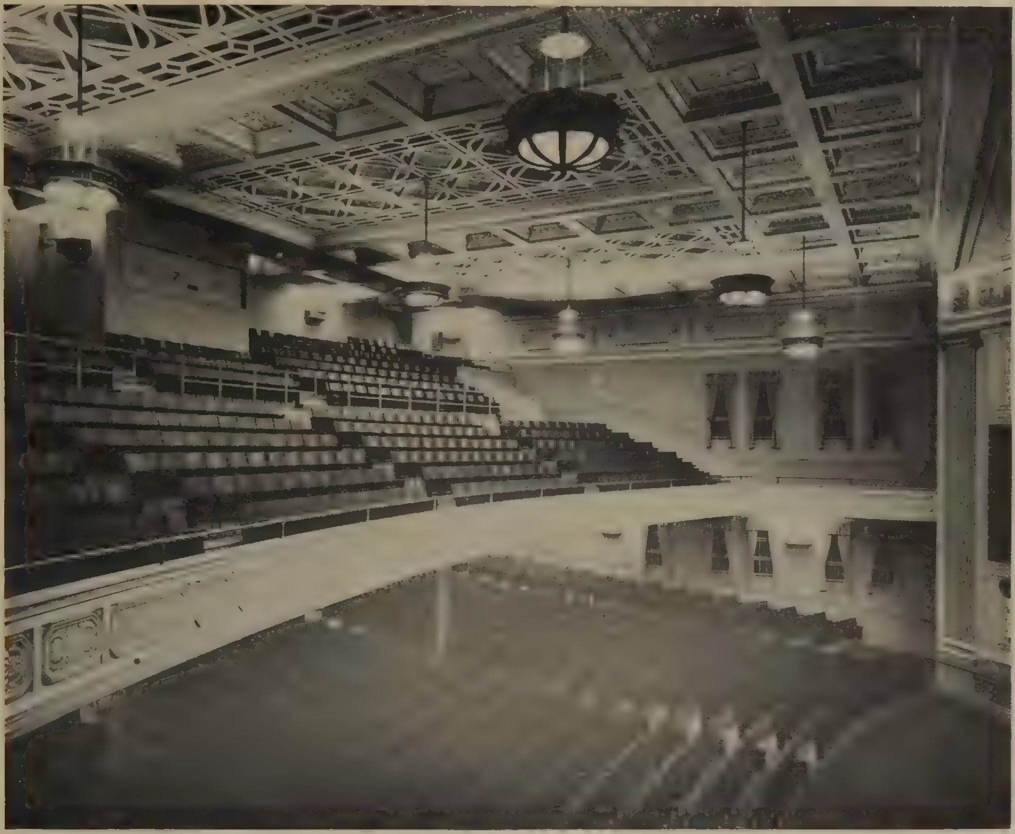


FIGURE 212—Civic Auditorium, Oakland, Cal. Indirect lighting serves two purposes here. It provides the audience with a generous quantity of comfortable illumination and also serves to reveal the decorated ceiling.

banquets, dances, exhibitions, conventions, and general assembly.

In new buildings there is always an opportunity to provide for proper lighting conditions, and we have many examples of public assembly places where much thought has been given to the illumination, as, for example, in the Minneapolis public auditorium shown in Fig. 209, and the Cleveland public hall in Fig. 210. It is with a great sense of comfort that the public attends meetings in properly illuminated auditoriums, where no glaring lights are present to distract and annoy.

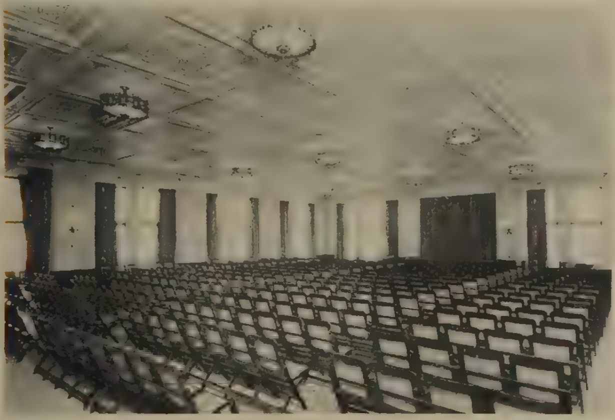


FIGURE 213—Assembly Hall, Southwestern Bell Telephone Company, Dallas, Texas. Lang & Witchell, Architects. Reproduced from a daylight photograph.

The Municipal Auditorium of Minneapolis, Minnesota, has a type of lighting that adds dignity to this great municipal structure. Cove lighting supplemented by a skylight has been adopted because it provides seeing comfort for vast audiences, and also enhances the sense of spaciousness of this large interior. In the design of the structure provision was made for cove lighting at two principal locations, as shown in the illustration. One of the interesting features of the illumination of this enormous room is the fact that a complete system of color effects has been provided. In the

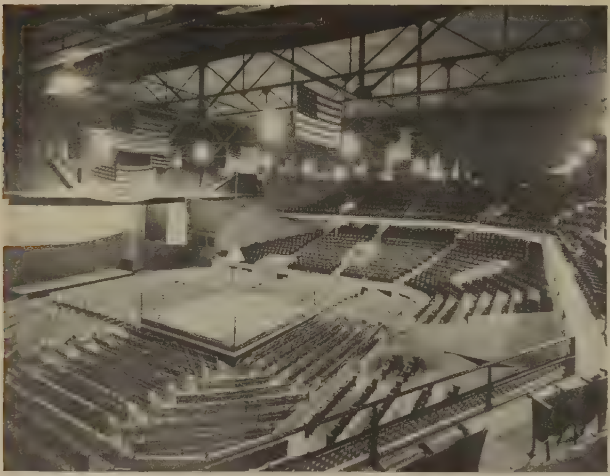


FIGURE 214—Arena, Soldiers and Sailors Memorial Building, Kansas City, Kas. Rose and Peterson, Architects. Typical of many arenas in our American cities, and appropriately equipped with direct lighting.

lower cove two types of special X-Ray reflectors, fitted for red, blue and white colors, are installed, all under the control of circuits into which dimmers have been inserted for the varying of the lighting intensity.

Likewise in the upper cove a series of red, white and blue lights have been provided in reflectors which accommodate 150-watt lamps. The medium for obtaining the color variations is a glass lens, of the type shown on page 285, attached to the reflector by means of a special holder. The use of this heat resisting and permanent color lens makes it unnecessary to employ dipped or colored glass lamps of any kind. It is much more desirable, wherever color lighting is used, to adopt permanent filters with clear lamps, rather than dipped or colored lamps. The color is uniform, and stocks of lamps are minimized, and replacements of the lamps are more economical.

The immense auditorium of the Cleveland public hall, with seating capacity for 13,000 persons, is also lighted from coves, with X-Ray reflectors both in white and colors. This auditorium has housed several of the national presidential conventions. It is suitable for automobile shows, grand opera, and many other purposes. The lighting scheme has been found eminently satisfactory for all these various activities. The stage, which is frequently found in large public auditoriums, has lighting similar to that provided for a standard theatre stage, details for which are discussed on page 127.

For the smaller type of assembly hall the illustration in Fig. 211 is typical. This room, in the Memorial Union Building of the University of Wisconsin, has a scheme of lighting much like that for the Minneapolis auditorium, except, of course, reduced in scale. A combination of cove lighting and skylighting has been provided, thus eliminating entirely the presence of fixtures suspended from the ceiling, giving the room a larger

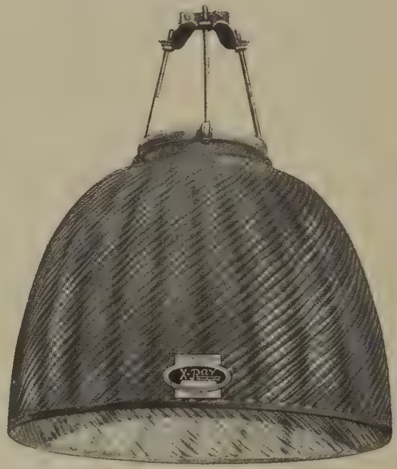


FIGURE 215—Style of X-Ray reflectors suitable for illumination of interiors such as shown in Figures 214 and 216.

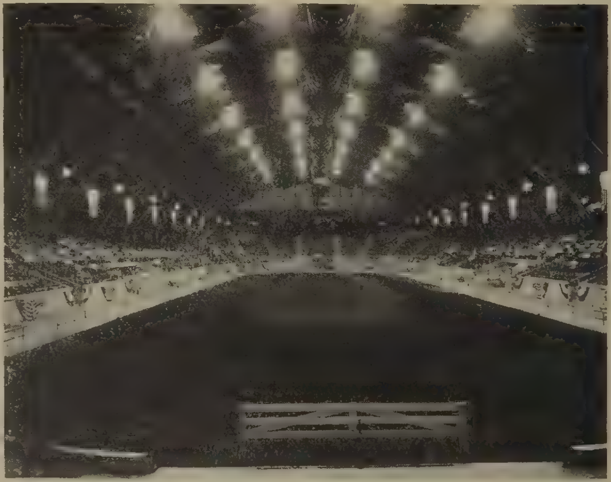


FIGURE 216—Michigan State Fair Coliseum, Detroit, Mich. Ray S. M. Wilde, Electrical Engineer. Maximum lighting concentrated over the arena, subdued illumination for the audience.

and higher appearance and a desirable flexibility in the lighting intensities for many occasions.

The Civic Auditorium of Oakland, California, shown in Fig. 212, has a design not unlike that of the theatre, with a rather large stage and extensive balcony. Appropriate and flexible lighting has been provided by suspending from the ceiling a luminous type of indirect fixture supplemented, for the rear balcony and under balcony sections, by wall lighting boxes, containing specially designed reflectors.

In the illustration of the Kansas City Soldiers and Sailors Memorial Auditorium the stage is arrayed for a boxing contest, thus exhibiting another use for which a public auditorium must frequently be employed. Because of the type of architectural construction, the lighting of this room does not call for as much artistic treatment as is to be found in the previous example. A system of direct lighting has been adopted, using reflectors of the type shown in Fig. 215 for 500-watt lamps. Even though the maximum of the illumination is downward, the reflectors are of such design as to very effectively shield the bright filament of the lamp from the view of those seated in the auditorium. By proper arrangement of the electrical outlets an equal lighting value is received in all parts of the room.

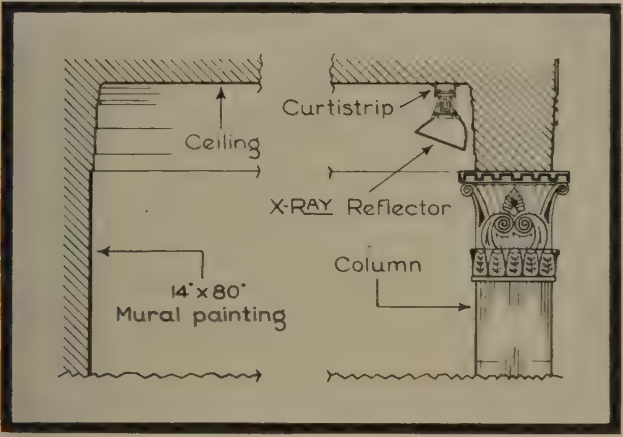


FIGURE 217—Diagram showing the method of illumination of mural paintings in Baltimore Memorial Building, with X-Ray reflectors concealed behind beams.

A similar method has been adopted for the Coliseum of the Michigan State Fair, shown in Fig. 216, where the central portion of the building is largely taken up by the huge arena. It will be noted that most of the lighting equipment is concentrated over the arena, with lamps suspended from the roof trusses, closely spaced and symmetrically arranged. A separate scheme of lighting has been adopted for illumination of the area occupied by seats. A more subdued value is provided here, sufficient for the reading of programs but not bright enough to interfere with concentration of attention on the arena.

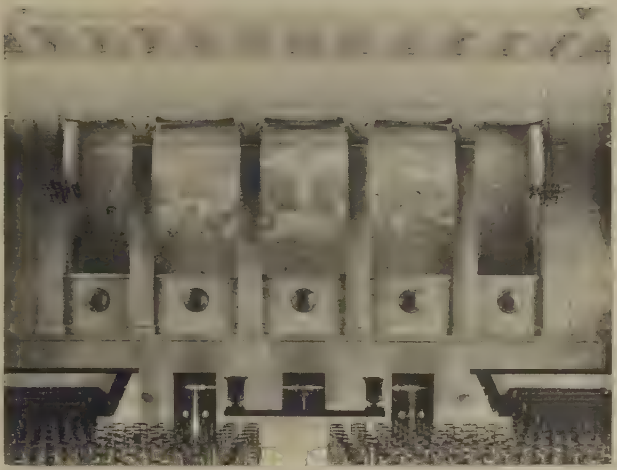


FIGURE 218—War Memorial Building, Baltimore, Md. Lawrence Hall Fowler, Architect. The great mural painting is illuminated from equipment entirely concealed from view.

Because of the high suspension of the units, the lamps are entirely out of the normal range of vision, thus glare is avoided. Furthermore, means for lowering the lamps and reflectors to the floor have been provided for the purpose of maintenance, using a safety hanger of the type in Fig. 408.

In many auditoriums frequent use is made of the stereoptican lantern and moving picture machine. It is important, therefore, to provide means for dim lighting while the lantern is employed. The subdued lighting should not be so low in value that the audience will have difficulty in readily locating seats, or be confused in moving about. Control is easily arranged by placing the lights on more than one circuit, so that by the throwing of switches the auditorium may be flooded with light or suffused with dim, soft glow, sufficient for every purpose but not interfering with the clearness of the pictures on the screen.

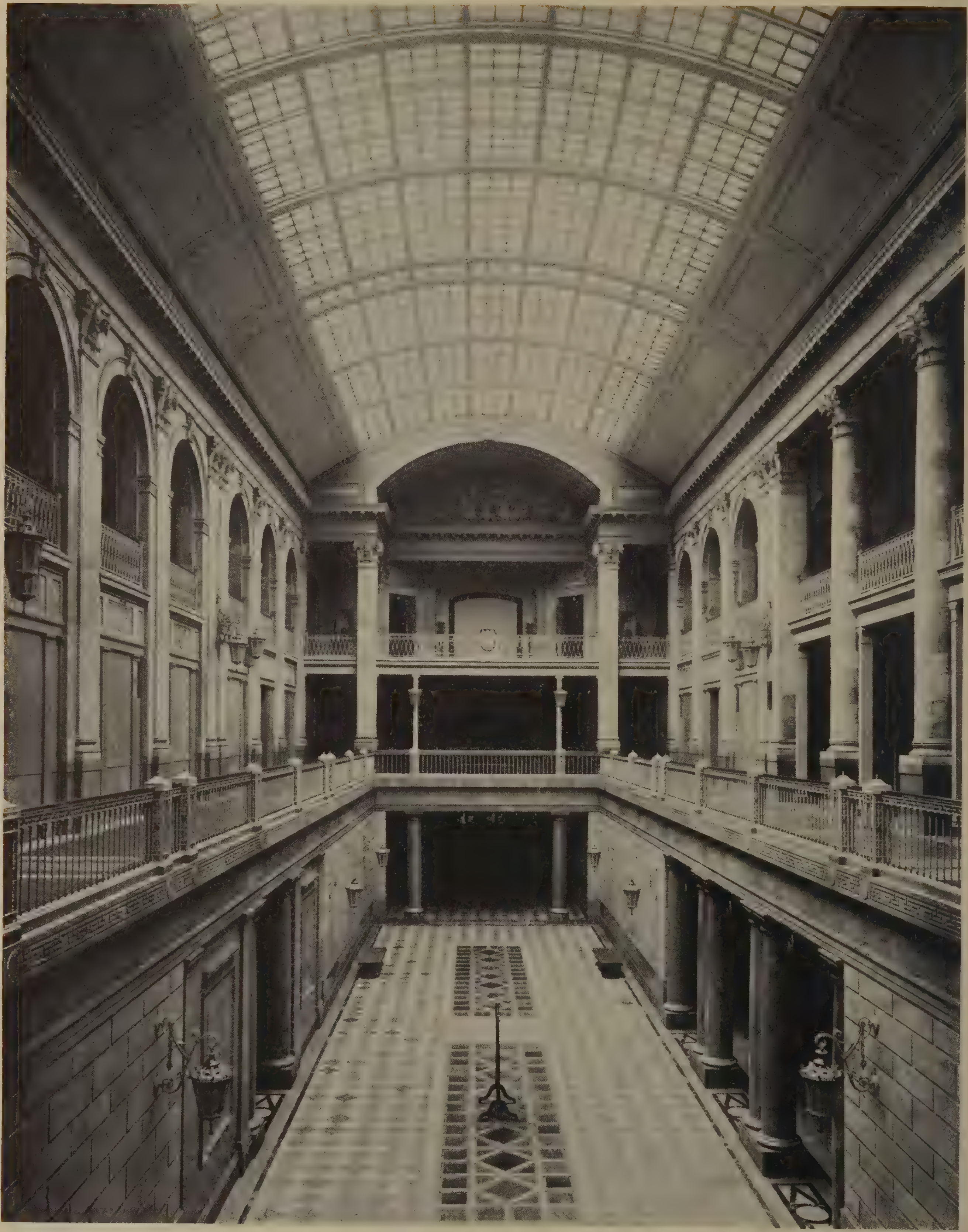


FIGURE 219—The Atrium, or public lobby of the Municipal Building in Hartford, Conn. Davis and Brooks were the designing architects. Not unlike daylight is the artificial illumination received from the ceiling skylight. Many X-Ray reflectors, arranged in symmetrical rows above the glass, produce this diffused and agreeable radiance.

GOVERNMENT BUILDINGS

EVERY nation that calls itself civilized has established what is known as Government, an agency which carries on the public business, a combination of customs, persons and ideas that directs the action of the people in their relations with one another. Social relations have become so complicated that the citizen finds his allegiances have been multiplied. He has a responsibility to the nation, another to the state, and still further obligations to the municipality. Those who have been vested with the dignity of office, those who define our rights and duties, those who help conduct the numerous activities that cannot properly be performed by our individual effort must be housed and provided with working facilities. The governmental buildings represent the pride and prosperity of the people. They are structures built to endure with the nation, and embody the patriotic instincts of the people.

From the standpoint of lighting, places of assembly for the legislative bodies of a national congress of representatives have many characteristics in common with general places of assembly as described on page 131. These halls are frequently used many hours at a time; therefore conditions should be comfortable for reading.

The portions of the building that are devoted to offices differ in no very definite way from similar spaces in general business and commercial structures, hence the same principles and practice

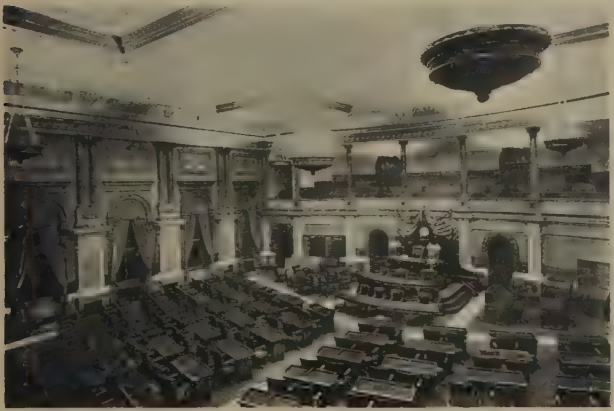


FIGURE 220—Representatives Hall, State Capitol, Topeka, Kansas. Charles D. Cuthbert, Architect. Numerous old chandeliers with glaring lamps were replaced by indirect luminaires.

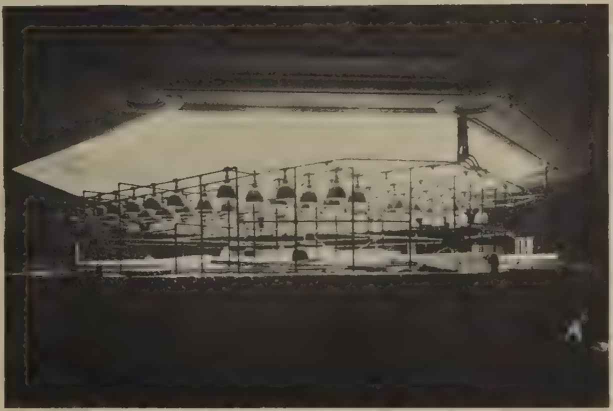


FIGURE 221—The Capitol building for the Republic of Cuba, designed by Eugenio Rayneri, has an equipment of X-Ray reflectors above the ceiling of the Senate and Congress library.

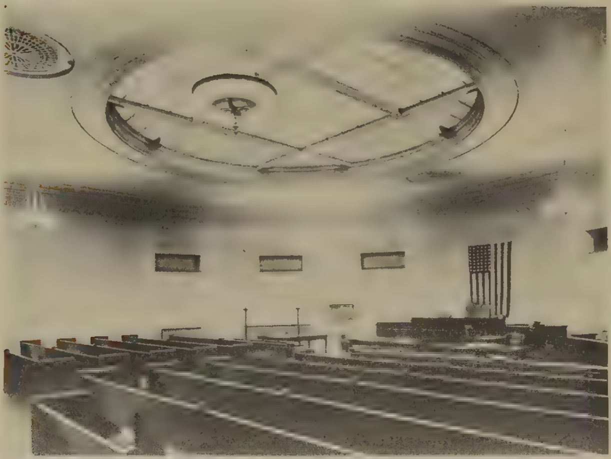


FIGURE 222—The Niagara County Court House, Niagara Falls, N. Y., combines a skylight with decorative luminaires for variety in lighting effect.

may be applied. These have been discussed on page 69, with examples of the best usage.

In the corridors, entrances, vestibules and lobbies especially the decorative feature may be a dominating element, but seeing comfort is very essential, because of the many small groups that assemble here before and after the deliberations of the main body. Inscriptions, murals, etc., depicting scenes of the nation's struggles must be appropriately revealed to an appreciative public. Committee rooms and jury rooms are similar in many ways, as regards their lighting requirements to the conference room.

Rooms set apart for the judicial branches of government are, as we know, devoted to the handling of cases of violation of the civil law, but too frequently in their lighting arrangements they provide us with striking examples of the most flagrant violation of a natural law, in that the unshaded lamps supported by brackets at each side of the judge's desk are allowed to cast their full glare into the eyes of those sitting in the room. Many public rooms in governmental buildings are

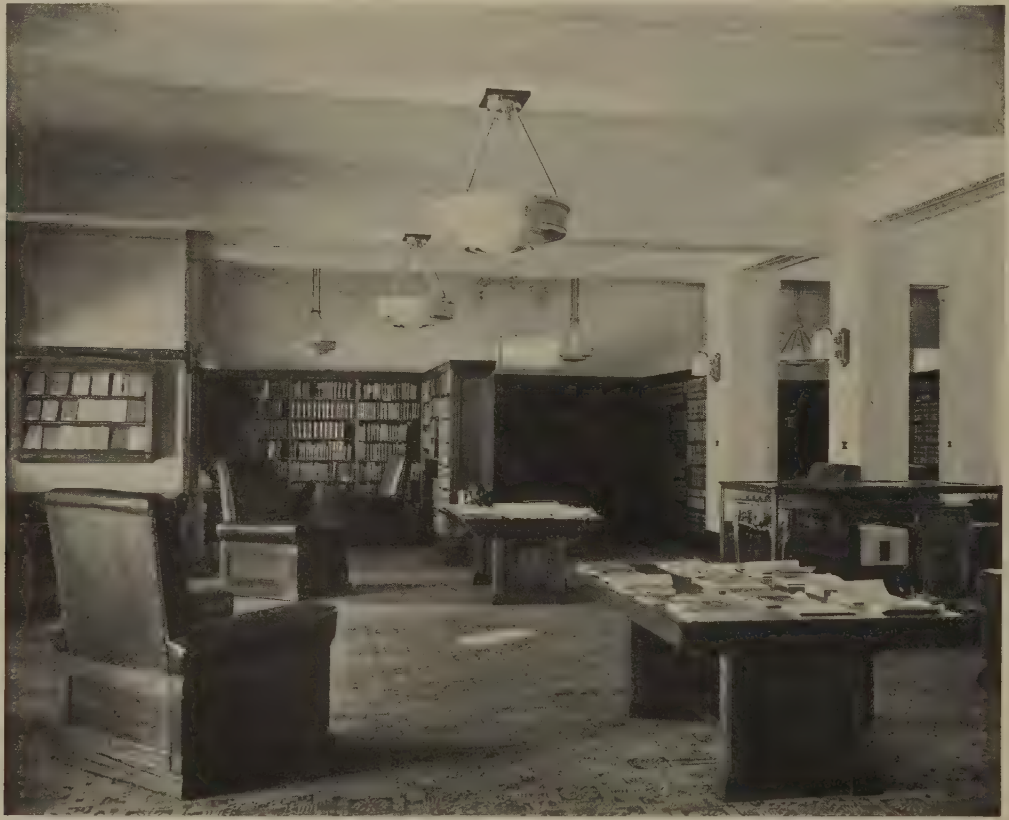


FIGURE 223—Reading room of the Commonwealth Capitol of Australia at Canberra. Walter Burley Griffin, Architect. This daylight view shows the indirect lighting fixtures, designed in harmony with the unique character of the Capitol building.

equipped with wall brackets in addition to the fixtures for general illumination, and very frequently, when the speaker is addressing the assembly, glaring sources behind the platform are allowed to shine into the eyes of persons endeavoring to concentrate their attention on the remarks of the speaker. Lamps should be entirely concealed from view, either within the body of a suspended indirect luminaire, as in Fig. 220, or in some structural element of the building.

The new capitol building of the Republic of Cuba, at Havana, is an imposing structure that expresses the spirit and aspirations of that hopeful, ambitious New World republic. This beautiful building is the design of Eugenio Rayneri, Director Tenico y Artistico for the Cuban Government. The important interiors of the building are cove lighted by X-Ray reflectors. The Senate and Congress assembly chambers and the library receive their natural lighting through large skylight glasses. The artificial illumination is planned to produce a similar effect. Fig. 221 shows a view

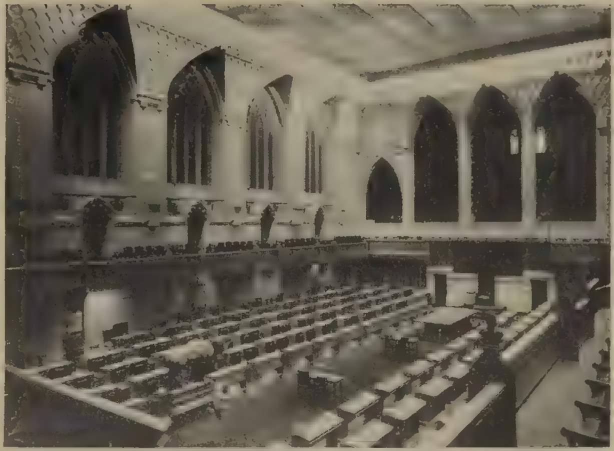


FIGURE 224—The Commons Chamber of the Canadian House of Parliament at Ottawa. Darling and Pearson, Architects. The decorative crown near the ceiling was utilized for the concealment of X-Ray reflectors, whose rays are directed downward upon the desks.

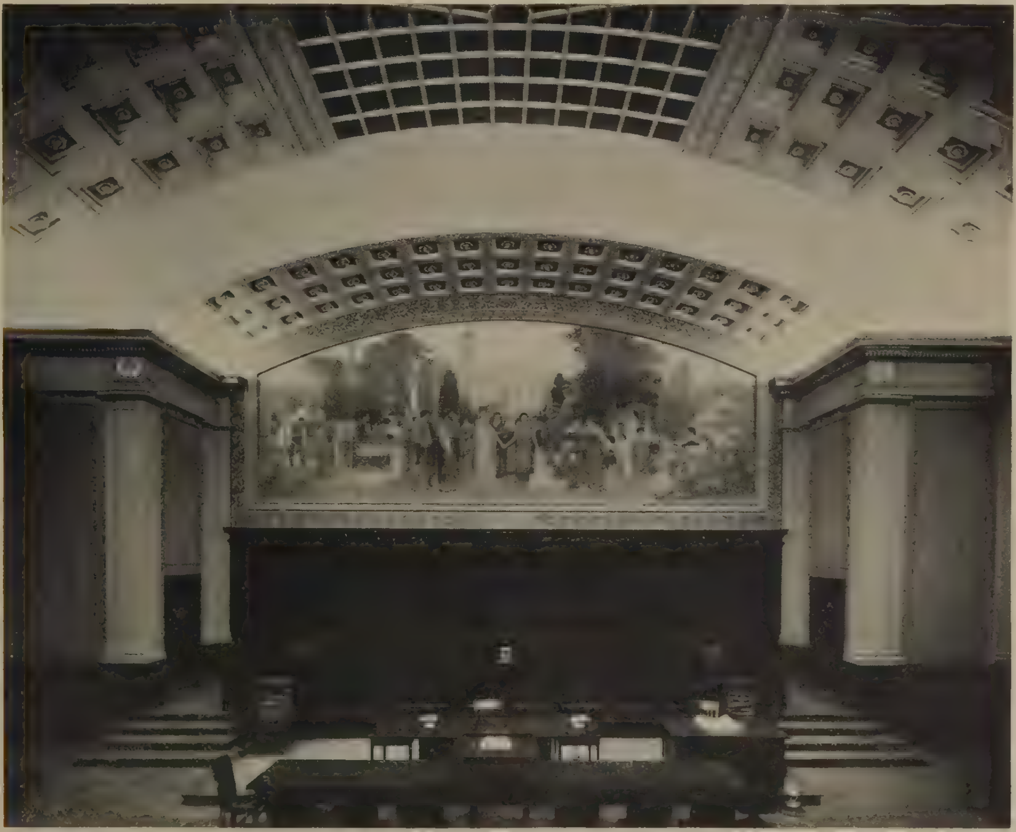


FIGURE 225—The Supreme Court Room of the State Building in San Francisco, California. George B. McDougall, Architect. The beautiful mural of "The Commonwealth" is revealed in magnificent detail by diffused illumination from X-Ray reflectors in cornice recesses.

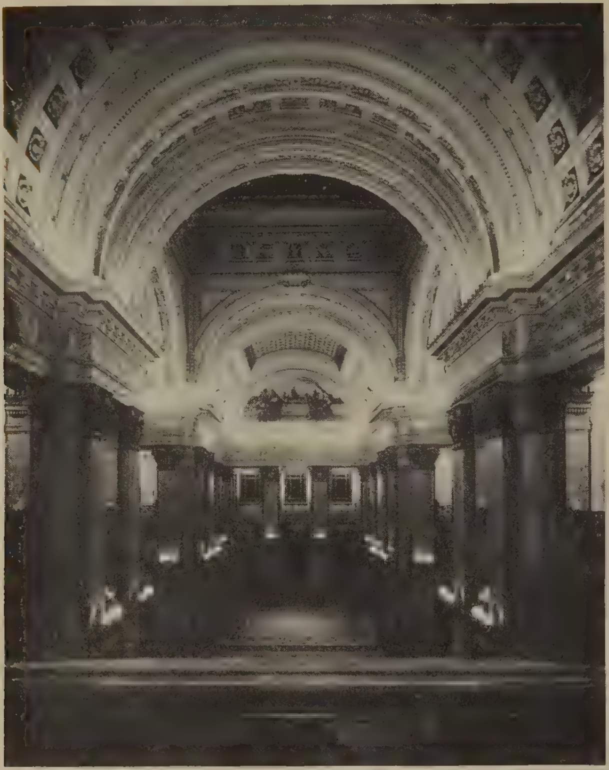


FIGURE 226—Salon de Pasos Perdidos, Legislative Palace, Montevideo, Uruguay. The wealth in decorative detail and mural painting are most effectively revealed by the means of illumination employed.

within the dome of the library, with reflector equipment installed for the artificial lighting. The close spacing of units and the use of large lamps insure uniformity of diffusion over the skylight glass and a generous intensity of illumination in the room below. One of the most interesting spaces in the interior of the building is the Salon de Pasos Perdidos, an extensive passage 500 feet in length, which has a high arched ceiling and is illuminated completely by cove lighting with X-Ray reflectors installed in the cornice.

Skylight illumination is one of the most ideal methods for lighting of public buildings because of its daylight qualities of diffusion and softness. To be successful, however, this method must employ reflectors of highest efficiency because of the losses that occur in the transmission of light through the glass. Furthermore, reflectors must be of such design as to insure an even spread of light over the glass, yet concentrating their maximum flux through it. A very important consideration is the selection of the type of glass employed. It must absorb as little of the light as possible, it must be of a diffusing character so that the light will be properly distributed into the space below, and the surface must be broken up in such a manner that any view of the mechanical equipment above will be obscured.

Usually considerable attic space is provided where skylights are used. This is advantageous because the reflectors should be placed above the glass at least four feet. In the case of the Hartford City Hall the reflectors are eight feet above the glass, spaced 3 feet by 6 feet apart, and arranged in 15 rows; thus the skylight surface is covered with a uniform brightness.

The reading room of the Capitol of Australia, at Canberra, is equipped with opaque indirect fixtures. For the House of Representatives and Senate it was desired that the Commonwealth Capitol fixtures be made in Australia. They were, however, designed to contain X-Ray reflectors as their interior equipment. The illustration in Fig. 223 shows a daytime view of the library with an indirect lighting fixture to harmonize with the unique type of design adopted by the Capitol City, modern in its general feeling.

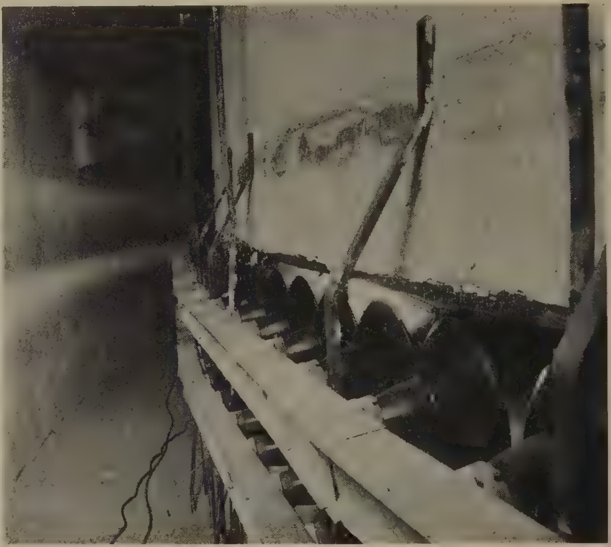


FIGURE 227—Cove lighting arrangement similar to that employed for the lighting of the Capitol in Uruguay. The equipment is easily accessible for cleaning and lamp renewals.

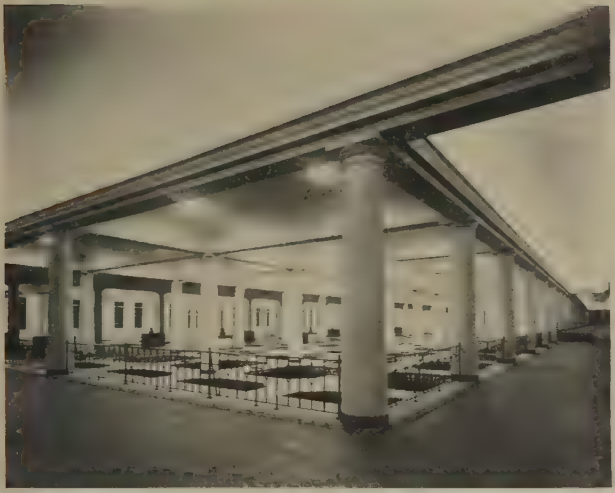


FIGURE 228—Filtration Plant at Washington, D. C., designed by U. S. Army engineers. The general illumination is from X-Ray reflectors in ceiling coves, with a concentrated direct lighting localized over each filtration bed.

The methods employed for the illumination of the Commons Chamber of the Parliament building for the Dominion Government of Canada, at Ottawa, it will be agreed are very unusual and mark this as one of the most novel installations that have recently been made, and in keeping with the dignity of the building. The structural features of the room made it necessary to resort to special methods. Ceiling fixtures could not well be employed. In this Chamber the members are seated on either side facing the center of the room. As the main illumination of the room is by direct lighting, it was necessary to so place the units that no objectionable brightness would be experienced by the persons in the room. The reflector installed was designed to cut off the light sharply on one side, hence with the units properly placed it is impossible for a representative seated at the opposite side of the Chamber to see the lamp when looking upward. Another system of lighting is provided to bring out the upper gallery crown ornament. The units for so doing were designed to give a band of light upon the rail section, causing this portion to be more highly illuminated than the area below.

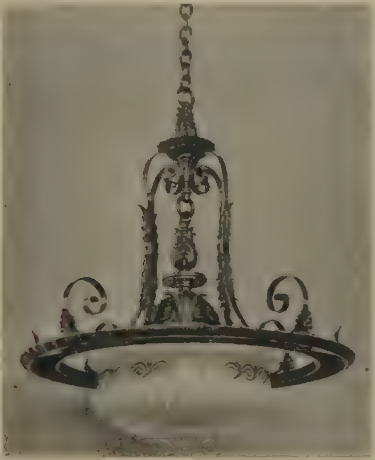


FIGURE 229—Indirect lighting fixture of the luminous bowl type, such as used in the illumination of the Monroe County Court House shown in Fig. 230.

The Supreme Court room at San Francisco, a building designed by the Department of Architecture of the State of California, is illustrated in Fig. 225. It has a beautiful mural entitled "The Commonwealth," which is revealed by the system of cove lighting. In the design of the illumination provision has been made for easy access to the equipment for its cleaning and for the renewal of lamps. In Fig. 227 is a typical installation with X-Ray reflectors of a type designed for the lighting of domes and arched ceilings in government buildings and other public structures. A general passage has been constructed back of the cove. The reflectors, wiring and all mechanical arrangements are readily accessible. Here a double row of units, installed on short sections of sheet metal channel, are joined together.

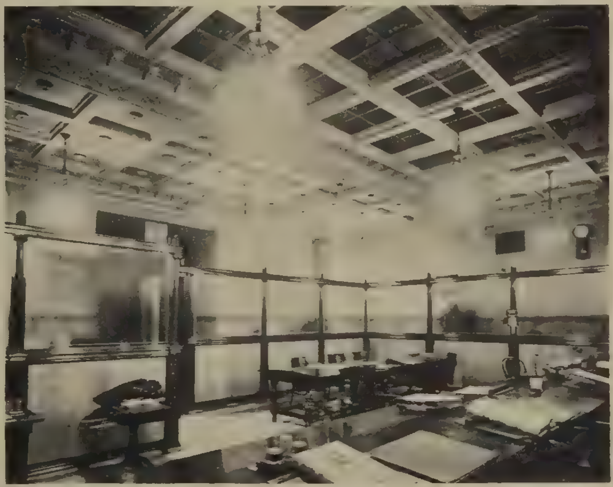


FIGURE 230—The County Clerk's office, Monroe County Court House, Rochester, New York. John F. Stroebel, Architect. Abundant lighting from a decorative luminaire of bronze.

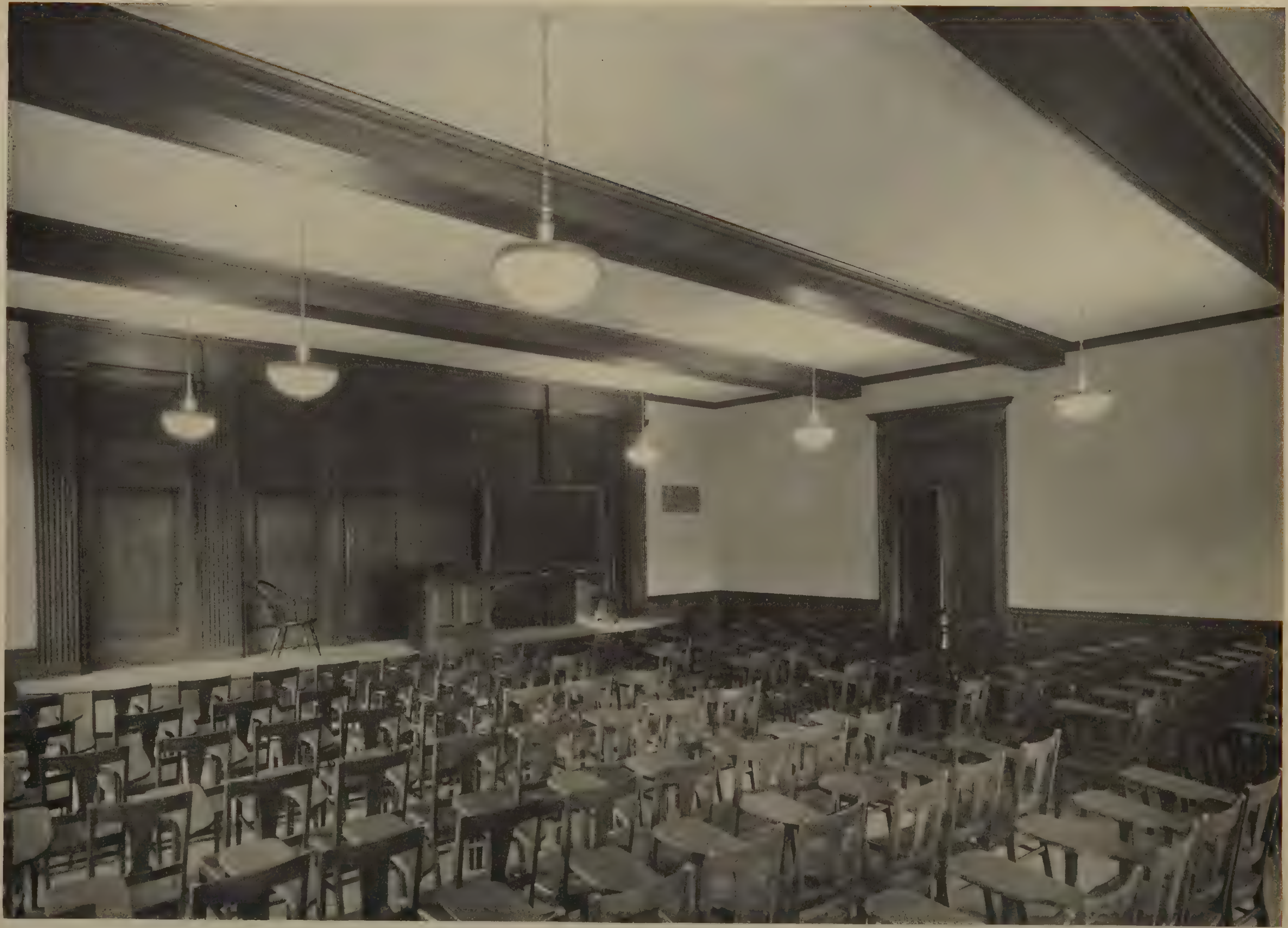


FIGURE 231—Lecture room in the School of Languages, Brown University, Providence, Rhode Island. Pearsall and Mills, New York, Architects. The luminous bowl fixtures are pleasing in appearance and give lighting that is a comfort to the eyes of the speaker and the student, enabling both to derive the maximum benefit.

EDUCATIONAL BUILDINGS

AT THE time a youngster of today reaches the age of six years, or thereabouts, his serious education begins. He is partially removed from the watchful eyes and indulgent hands of his parents and placed for an important period of the day in charge of teachers in public and private schools. It is a totally new life for the child, a life of restraint and concentration, of enormous visual tasks, tasks consuming nerve energy. It is a period of mental adaptation for the child as well as a time of adjustment for his eyes.

This change in the child's life may not at first appeal to us as being particularly serious. We take it more or less as a matter of course; but as the years go by and the tasks begin to increase, troubles and defects develop, for which our minds do not always detect the real cause. The aim of the school is to develop vigor of mind and body, and it seems that the important position of the eye in this program is frequently overlooked.

A very definite idea of the kind of eyes that the future men and women of the world are to possess can be gained today by examining into the present ocular condition of the school children. As years go by the myopic eye will need greater refractive correction. The normal eye will develop defects, because we are giving the child's visual equipment greater tasks to perform and are not supplying it the assistance it should have in good lighting.

In a recent bulletin on physical defects of school children, published by the Department of the Interior at Washington, Dr. James Frederick Rogers stated that: "Vision is seriously affected by poor health and poor nutrition, and poor vision is always associated with poor lighting and other conditions which throw unnecessary strain on the visual apparatus. All schools should be properly illuminated. Work at home should be done under like conditions, if it is done at all."

In recent years thousands of school children have been examined, and the results show that at least 25% of them suffer from defects of vision, resulting largely from the continued use of the eyes for school work under unhygienic conditions. Defective vision is, in most cases, progressive, and it is, therefore, found to a greater extent among the older children. Defects of vision retard the progress of the child in school work. It may often seriously handicap him in after life. Conditions imposed upon the child's eyes by modern educational systems and methods make it necessary that the best possible working conditions be provided during the formative years. Improper and inadequate lighting causes eye strain and results in disorders that may be permanent. The immature eyes of children are especially susceptible, much more so than those of adults, because, as a rule, the student is using his eyes more continuously than do older persons.

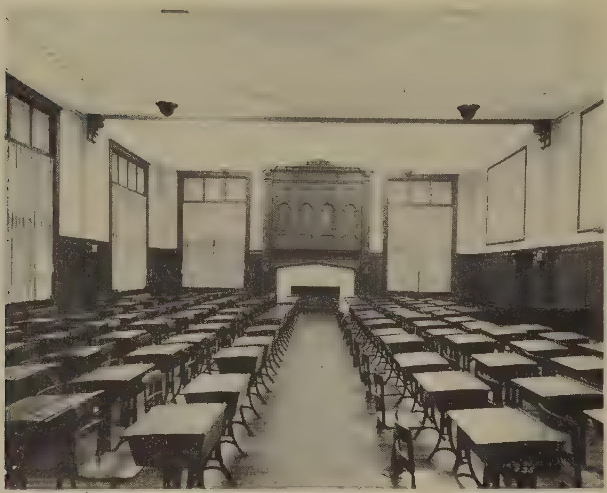


FIGURE 232—A large class room in the Fessenden School of West Newton, Mass. The kind of illumination that conserves the eyesight of the growing child.

All school buildings should be so equipped that when the natural lighting fails and pupils are required to study, an approved system of artificial lighting is immediately available. The growing use of schools for night work makes it doubly important that they have good illumination, since the night classes are of necessity entirely dependent upon the artificial light sources.

After a careful study of the conditions that prevail in the schools of the country, a committee of The Illuminating Engineering Society prepared a code of lighting for educational buildings. This code is intended to serve as a guide to legislators, departments of instruction, and other bodies interested in the formulating and enforcement of rules for the lighting of schools. It is intended also as a guide to architects in the planning of illumination for such buildings, and for school superintendents and others interested in the betterment of lighting conditions.

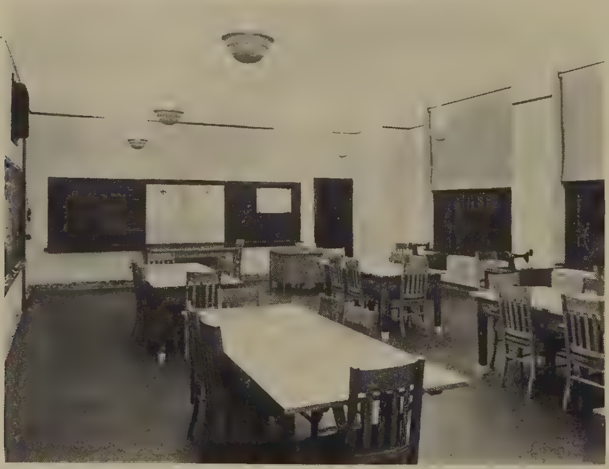


FIGURE 233—Sewing room of the Trott School, Niagara Falls, New York. Kirkpatrick and Cannon, Architects. Eight indirect fixtures in a room 20 feet by 40 feet are an ideal arrangement.

We are doing much to improve the lighting of our offices and workshops so that the maximum efficiency may be obtained from the worker. We sometimes overlook the fact that the relieving of eye strain and the conserving of vision should begin in the schoolroom and at home. The defects of the adult may be checked and sometimes prevented entirely by the safeguard of proper artificial lighting for the growing child. The good in his ocular equipment should be conserved and the bad improved. The actual conditions seem to be quite the reverse.

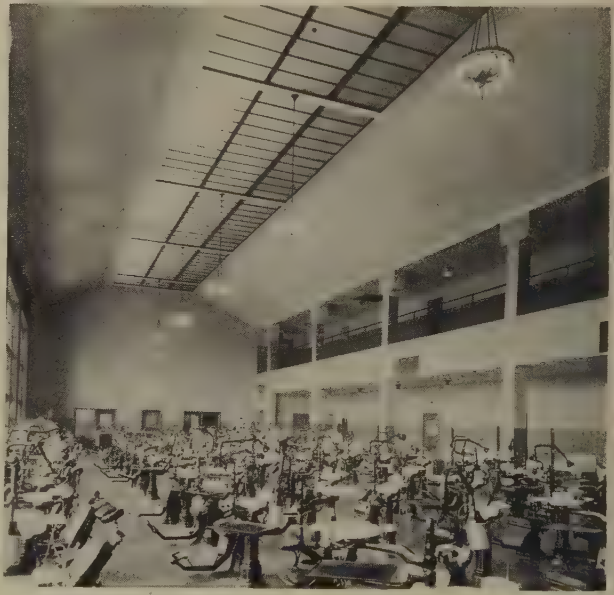


FIGURE 234—A daylight view of the clinic in Hamilton Hall, College of Dentistry, Ohio State University, Columbus. Artificial lighting comes from the skylight and the ornamental fixtures.

In our schools of today we find many undesirable conditions. The lighting is frequently inadequate; that is, too low in intensity. It is glaring, or is coming from the wrong direction. It is characterized by strong shadows, or is uneven in various parts of the room. It does not have the diffuse quality of daylight. And has many other characteristics that contribute to eye strain, which eventually leads to serious defects of vision.

Only systems which give a diffused illumination should be considered for classrooms. It has been shown by careful tests, such as those shown by Fig. 40, that indirect lighting most clearly approaches daylight in diffusion and in its effect upon the eye. Of all the systems and methods that are suitable for school lighting, indirect illumination embodies more of the qualities desirable for comfortable vision than any other. It does more than contribute to the conservation of eyesight.

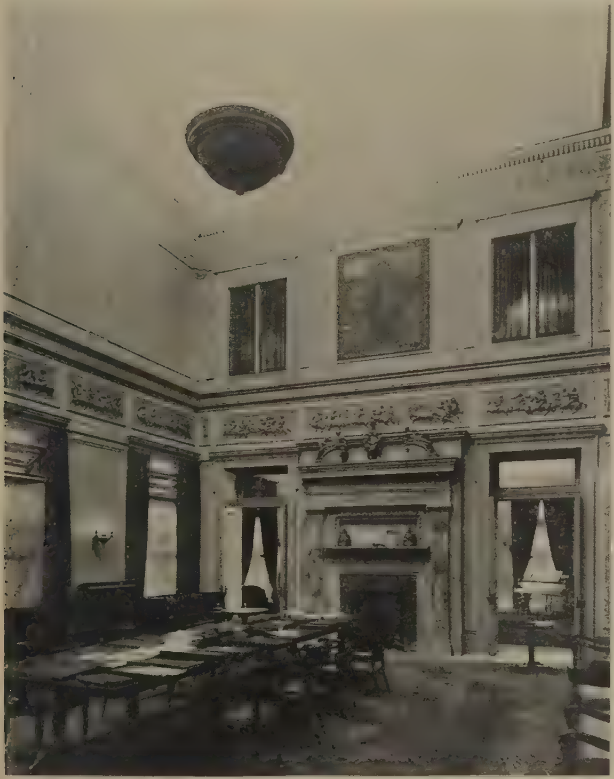


FIGURE 235—Officers' room, U. S. Military Academy, West Point, New York. The classical motif of the ornamental mouldings is reflected in the decorations of the indirect lighting fixtures.

It adds a note of cheerfulness to the general appearance of the room. It has a stimulating and enlivening influence upon the pupils. It minimizes eye fatigue, because it removes the possibility of glare. It supplies an even illumination for all the desks. All corners are well lighted. From all parts of the room characters on the blackboard are clearly visible. Shadows are exceedingly soft. There are no sharp contrasts in brightness. Annoying reflections from the surfaces of book papers and highly varnished desk tops are reduced to a minimum. In other words, it is truly a system for visual comfort and conservation of eyesight.

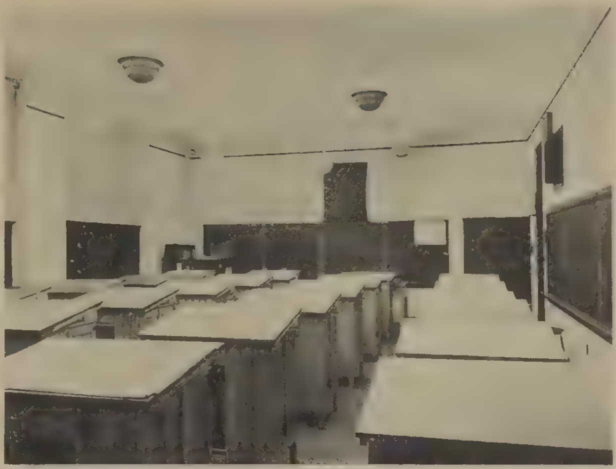


FIGURE 236—The drafting room, Trott School, Niagara Falls, New York. Kirkpatrick and Cannon, Architects. Lighted in the same manner as a commercial drafting room, with a generous intensity of well diffused illumination.

Good lighting, it is true, enables the child to see; but a generous illumination will speed up all visual operations. A recent interesting investigation shows that when the illumination is increased from 4 foot-candles to 16 foot-candles, the speed of reading is increased 15%, and that still further improvements are indicated at higher intensities.

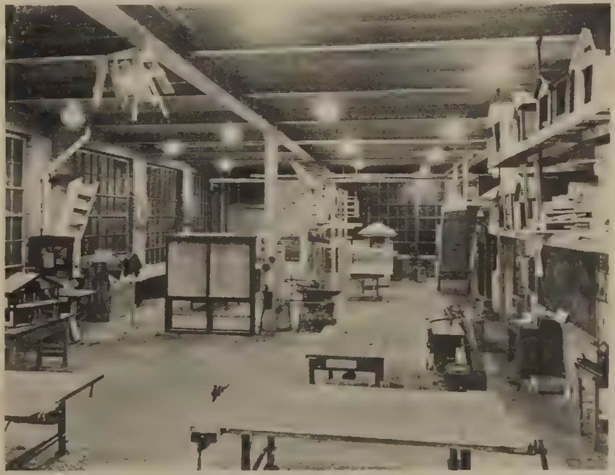


FIGURE 237—Department of manual training, public school, Niagara Falls, New York. Properly illuminated with direct lighting reflectors, spaced on close centers for even distribution in all parts of the room.

The importance of proper finish and color of the interior decorations is often lost sight of. Glossy surfaces should be avoided, as they are likely to cause glare. Desk tops and woodwork should have a dull finish. Walls and ceilings should be in light tones, so that no lighting equipment will be seen against a dark background.

In the average classroom an arrangement for artificial lighting to promote good vision includes the use of either six or eight electrical ceiling outlets. The typical classroom varies in size, but it approximates 24 by 30 feet, with a ceiling height of about 12 feet. A room of this character, illustrated in Fig. 233, is equipped with eight indirect lighting fixtures, each having a 300-watt lamp, or 3 watts for each square foot of floor area. The type of fixture employed is especially suitable for study rooms. The bowl is of metal, finished in a washable cream. It contains an X-Ray silvered reflector for maximum efficiency in the utilization of the light, and gives an illumination that is ideal from the standpoint of distribution and diffusion.

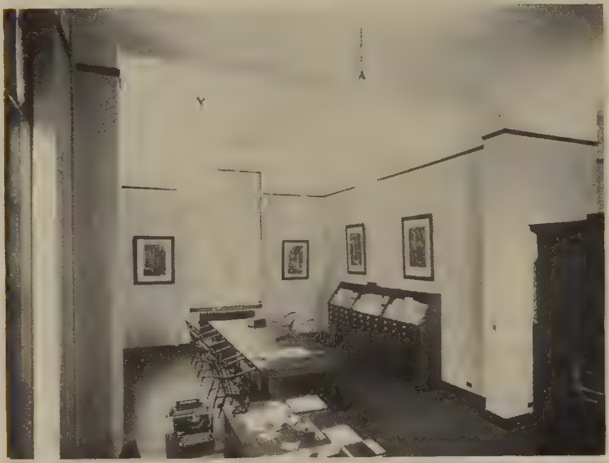


FIGURE 238—Reading alcove in the museum, Rhode Island School of Design, Providence. Note the lack of glare from objects and pictures on display.

The lighting of the drafting room in Fig. 236 compares favorably with that for a commercial drafting room. The carpenter shop in Fig. 237 is an excellent example of what should be provided for manual training departments in schools. The equipment consists of deep X-Ray direct lighting reflectors, spaced about 16 feet apart, on a ceiling 12 feet high. Each reflector diffuses the light from a 200-watt lamp. The illustration shows that additional outlets were very wisely provided, so that at any future time lighting units may be added if a greater amount of illumination is desired.

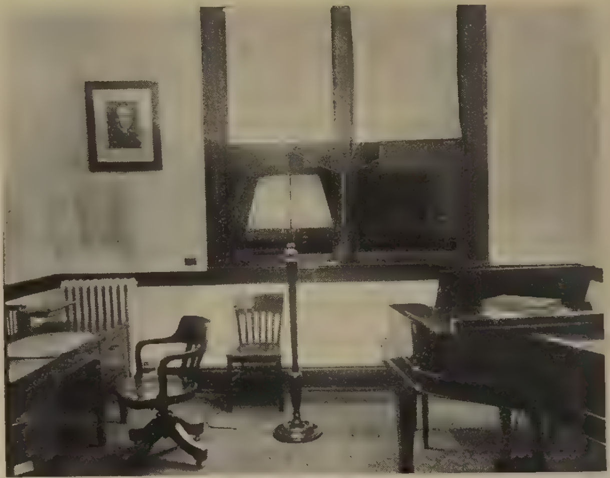


FIGURE 239—Professor's study, Smith Memorial Music Hall. University of Illinois, Urbana. James M. White, Architect. All useful lighting is from the indirect portable lamp. Ceiling fixtures could not be used.

It is not often that restrictions are as rigidly placed on the location of lighting outlets as are to be found in the case of the room in a school of music shown by the picture in Fig. 239. All studios and practice rooms are of soundproof construction, which made it impossible to use either the ceiling, the walls between adjoining rooms, or the

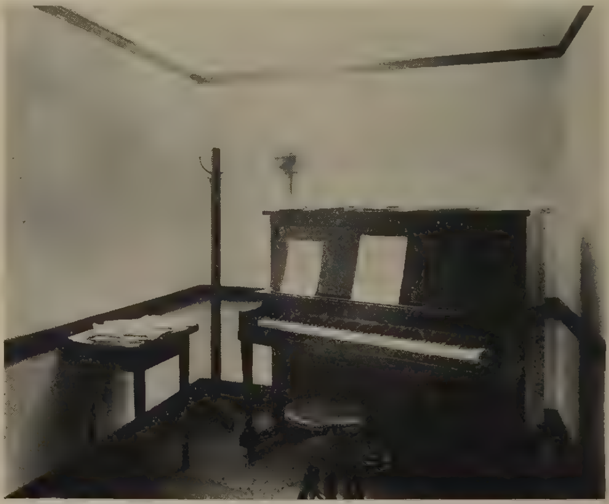


FIGURE 240—Typical practice room, Smith Memorial Music Hall, University of Illinois. Special indirect lighting equipment solved a difficult problem here.

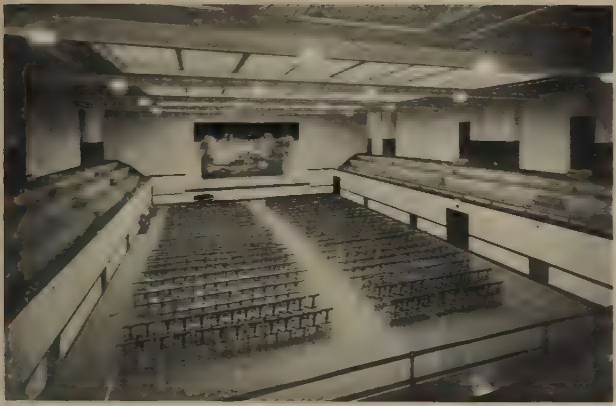


FIGURE 241—Assembly room and gymnasium, Redemptionist Fathers' School, Kansas City, Mo. Madori and Bihr, Architects. Recessed direct lighting is ideal for this type of interior.

floors for lighting outlets. In no case was the ceiling or floor construction to be punctured, because sound leakages would then occur. After considerable consultation with the architect, it was decided to illuminate the studios and practice rooms with indirect portable lamps from circuits contained in the outside walls of the building. The floor portable shown in the picture, and further described on page 201, illustrates the method. After this scheme was selected it was found necessary to devise some means to illuminate the room with a low intensity to enable one to see about sufficiently to turn on the indirect portable lamp. A cluster of lamps in silvered X-Ray reflectors was embedded in the doorhead, which was somewhat enlarged. These units are controlled from a switch on the corridor wall. The lighting scheme has been very successful, and illustrates the solution of a problem which was a rather puzzling one.

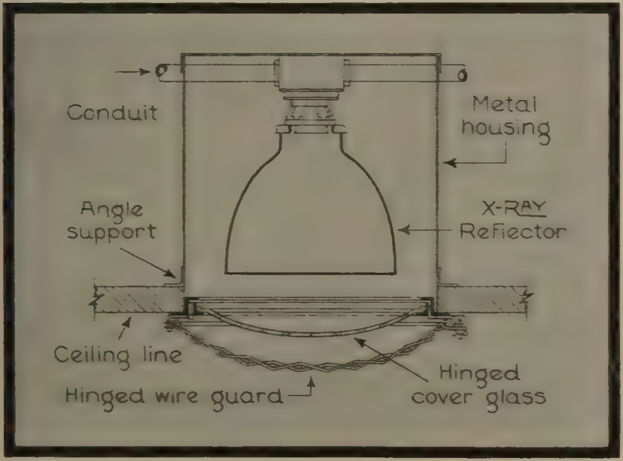


FIGURE 242—Detail of the method used for the room in Figure 241. X-Ray reflectors are recessed above the ceiling line.

In Fig. 241 is illustrated a room in the Redemptionist Fathers' school at Kansas City which is used for a double purpose, serving usually as a gymnasium, but on occasions as an auditorium. A well diffused and comfortable lighting is secured with a type of equipment such as shown in Fig. 242. Inasmuch as the use of the room as a gymnasium offered restrictions, all reflectors were installed above the ceiling line over a hinged metal rim with a glass cover. In combination auditorium-gymnasiums this is the practical solution of the lighting problem. Under balconies and other similar places where head room is limited, this type of unit provides adequate illumination and is neat in appearance.

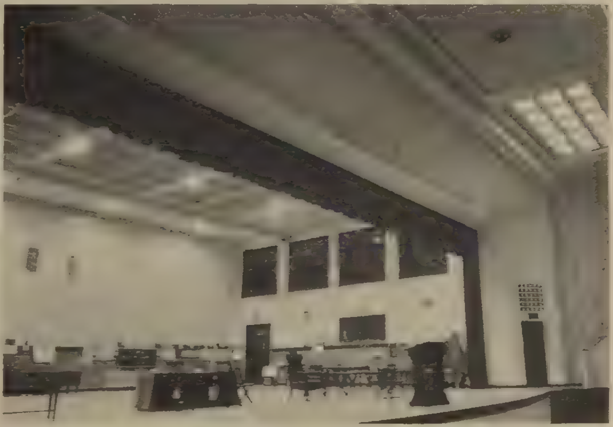


FIGURE 243—National Kindergarten and Elementary College, Evanston, Illinois. The gymnasium serves also as a stage and is frequently used for pageants.

In the assembly hall the lighting problem is mainly one of uniform general illumination. In school and college auditoriums, where frequent use is made of the stereopticon lantern, it is important to provide means for dim lighting. Assembly halls should never be totally darkened in schools for children of the lower grades. There should always be sufficient illumination so that the aisles and passageways are clearly visible. A low value of lighting may be used and yet not interfere with the exhibition of motion pictures or stereopticon slides. Flexibility may be obtained by using two circuits, one switch for a flood of

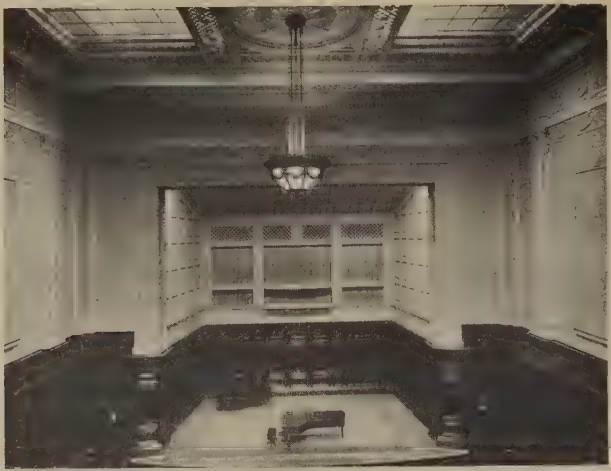


FIGURE 244—Auditorium of the Music Hall, University of Illinois, Urbana. James M. White, Architect.

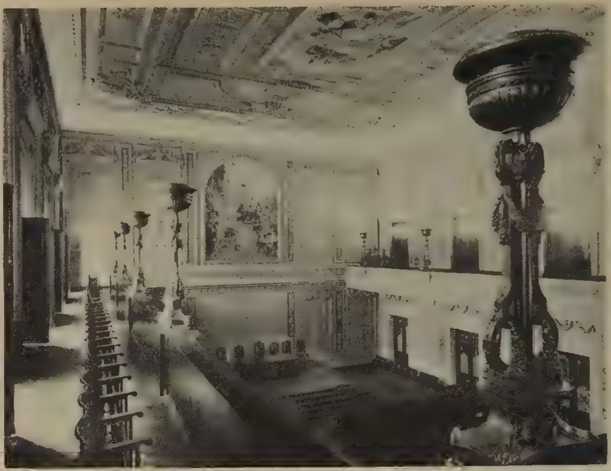


FIGURE 247—Auditorium, Military College, Mexico City, Mexico. Decorative lighting includes ornamental urns and cove units.

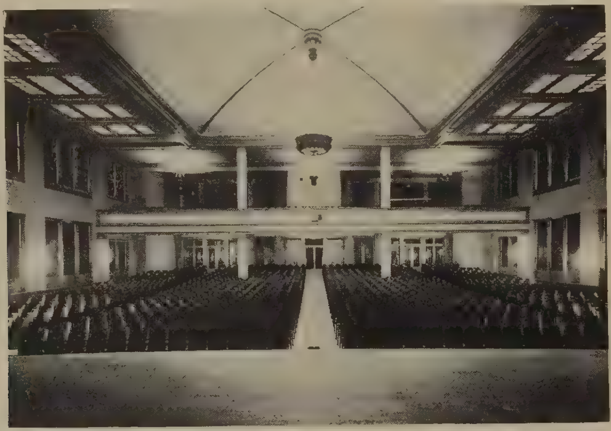


FIGURE 245—Auditorium, Gwynn's Falls Park High School, Baltimore, Md. Smith and May, Architects.

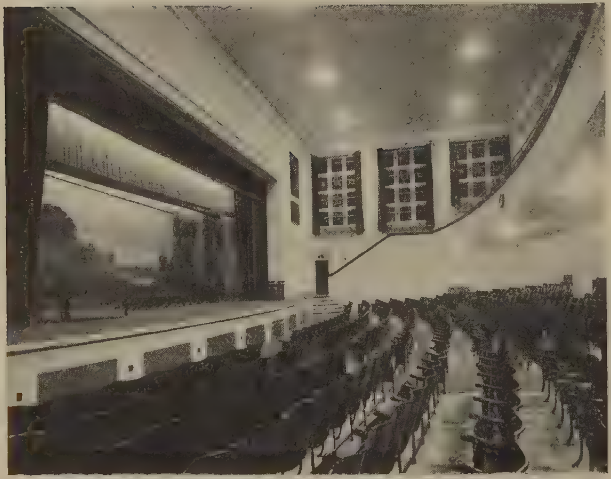


FIGURE 246—Liberty Memorial High School, Lawrence, Kansas. William B. Ittner, Architcet, St. Louis, Mo.

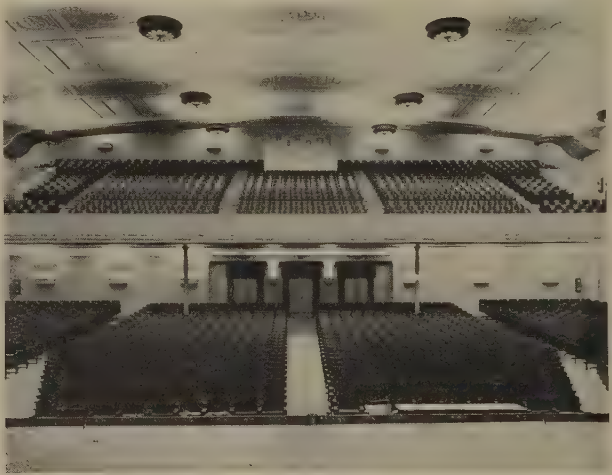


FIGURE 248—High School auditorium, Alameda, California. Carl Werner, Architect. Wall boxes and ceiling luminaires.

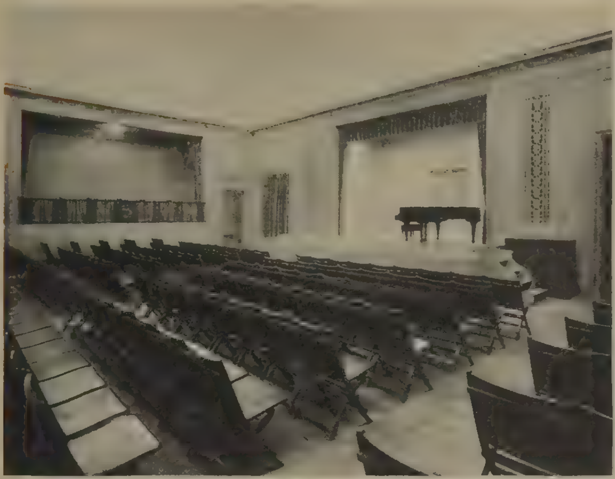


FIGURE 249—The auditorium of the Curtis School of Music, Philadelphia, Pa. Horace Wells Sellers, Architect. Reflector equipment like that shown on page 285 is concealed in the cornice.

clear, bright light, another switch for a dim, soft glow. Dimmers in the lighting circuit may be added at moderate expense.

A most important consideration is the providing of an independent service for exit and emergency lighting. If for any cause the main service in the building be interrupted, the emergency system should be immediately effective to prevent any danger of panic that might arise if exit indications were not clear.

Mr. William B. Ittner, a prominent architect and specialist in designing educational buildings, recently planned a school in which he desired to maintain an appearance of height in the auditorium. It was his idea to dispense with hanging ceiling fixtures and to devise a unit that would give a general lighting distribution from a position very close to the ceiling. A liberal amount of space existed above the auditorium ceiling in which the mechanical equipment could be placed. The unit finally adopted is used in the assembly room of Fig. 246. It consists of a very shallow cast brass circular frame, into which are set panels of hammered ornamental glass.

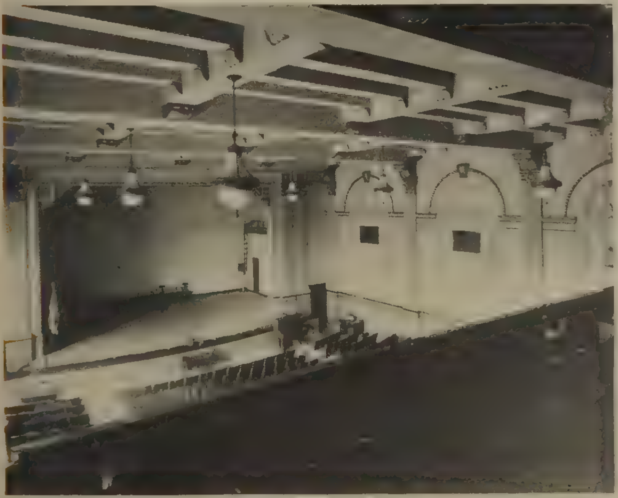


FIGURE 250—The auditorium of Jackson School, Detroit, Michigan. This daylight view shows the detail of the luminaire that totally encloses the lamp.

The walls and ceilings of the auditorium of the Military College of Mexico City are ornate, with mural paintings and stucco designs. Much study was given to the matter of supplying an adequate illumination so that the paintings would be properly revealed and that the lighting would be comfortable for those occupying the room. A balcony extends along each side of the auditorium, and at intervals along the rail are metallic bowls carried on elaborate pedestals. Concealed within are lamps with X-Ray reflectors, sending a volume of light upward, to be reflected by the ceiling by the method of indirect lighting. In the cornice near the ceiling line, and hidden from view, are about two hundred lamps and reflectors, whose light is projected downward and against the walls, mingling with and supplementing the upward light.

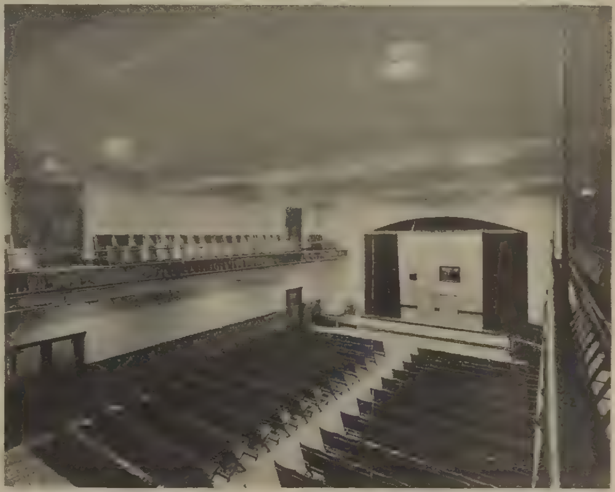


FIGURE 251—Assembly Hall of the Clay School, Topeka, Kansas. Thos. Williamson & Co., were the architects. The light is directed downward by reflectors concealed in an ornamental housing.

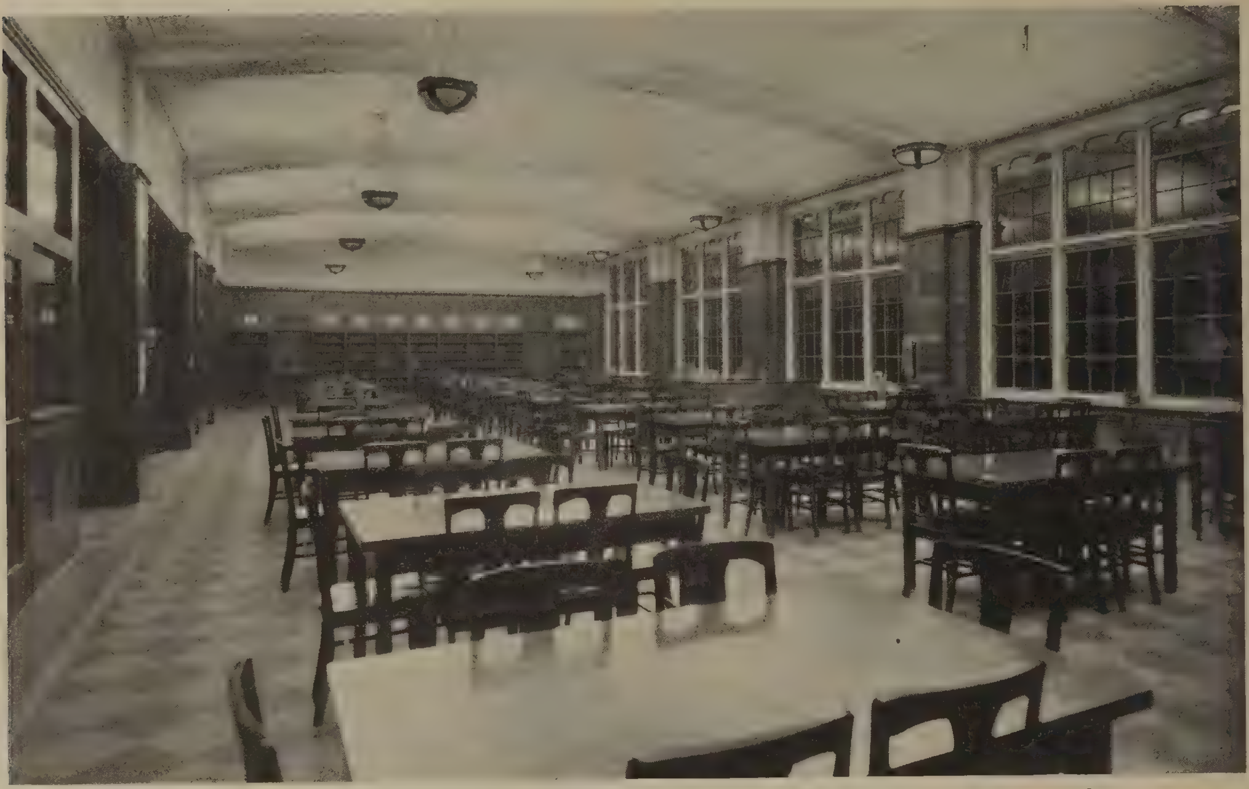


FIGURE 252—Library, Barbour Intermediate School, Detroit, Mich. Malcolmson & Higginbotham, Architects.

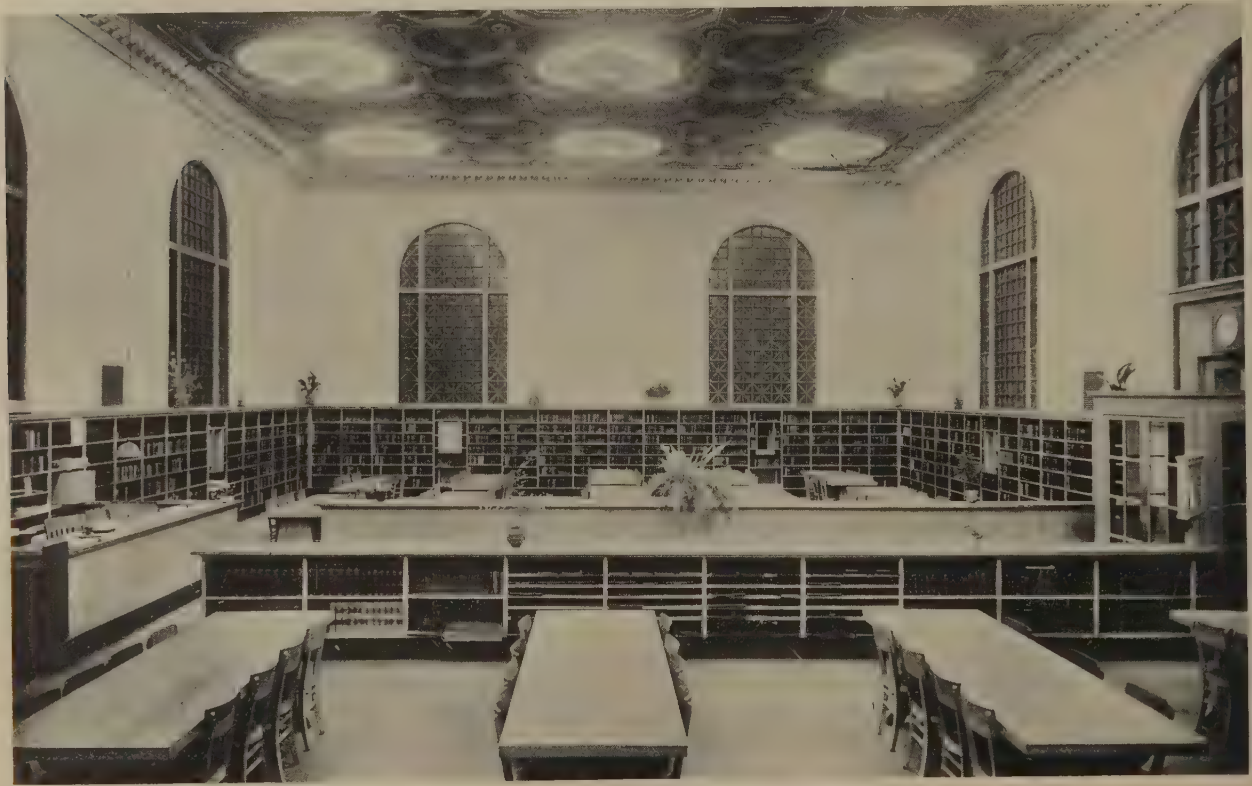


FIGURE 253—Richmond Public Library, San Francisco, California. Uniform illumination without glare.

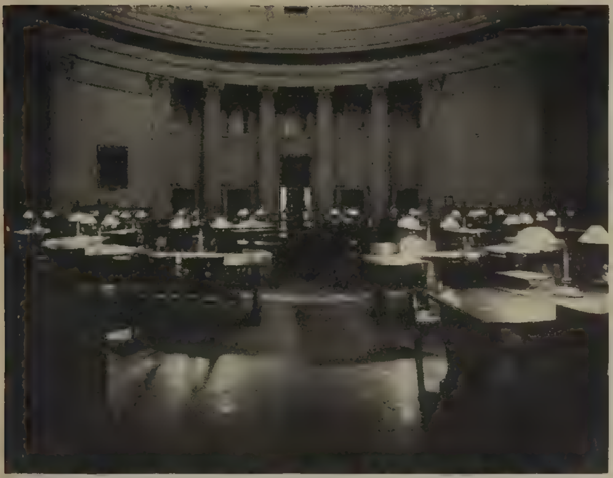


FIGURE 254—Library, Massachusetts Institute of Technology, Boston, with old lighting system.

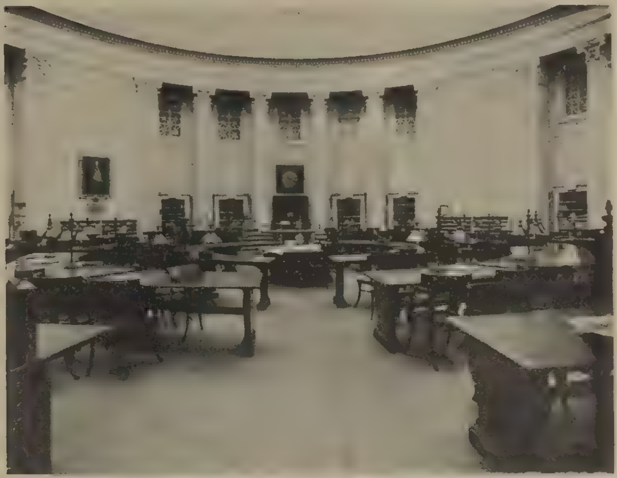


FIGURE 255—Massachusetts Institute Library after lighting system was revised.

Libraries

In our schools, colleges and public libraries, wherever reading facilities are provided, the comfort and hygiene of the eye should have very thoughtful attention. More than ever before in the history of building do the architects and custodians of libraries recognize the value of their trust in respect to the conserving of priceless eyesight. Whatever means are available for securing the greatest possible comfort for the eye, this means should be specified.

In the large public institutions where funds are frequently liberally provided, the illumination facilities come in for considerable attention. It is, however, in the public and parochial schools of our country that the closest attention should be given to the provision of proper artificial lighting. Too often the question of price, beauty or brilliancy of lighting units is the criterion upon which good lighting is judged rather than the effect upon the eye. When we consider that about 10 per cent of the school children have defective eyes, this matter is further emphasized. A child's eyes mature rapidly, and are quickly susceptible to injury from glare or poor lighting. Under normal conditions a child will complete the eight grades at the age of fourteen. If on account of defective vision only six or seven grades are reached at that age, the loss to the child and the public at large cannot be justly and adequately estimated.

Since poor lighting and glare are directly responsible for eye strain, and result in nervous disorders, several states have provided rigid school lighting codes. These insist that the light sources be concealed, and that proper equipment be designed and installed for each particular lighting requirement.

Recently the American Medical Association conducted considerable research to determine the best method of artificial lighting from the standpoint of the health and efficiency of the eye. All forms of lighting and types of equipment were given unbiased tests by the committee. The committee reported: "Of the methods of artificial illumination, the indirect lighting was the best. In this method the source of light is concealed from the eyes, the light being reflected to the ceiling and walls and from these to the working surface. With daylight and the indirect system a wide range of illumination allows the eye to continue its work for several hours without undue strain or considerable falling off in efficiency."

The Barbour Intermediate School, Detroit, which is illustrated in Fig. 252, has a particularly satisfactory type of lighting. The picture, which was taken by means of the artificial lighting only, shows its uniform character and lack of glare. Reading may be done with the greatest of eye ease, and any book on the reference shelves may be selected with facility. The type of luminaire

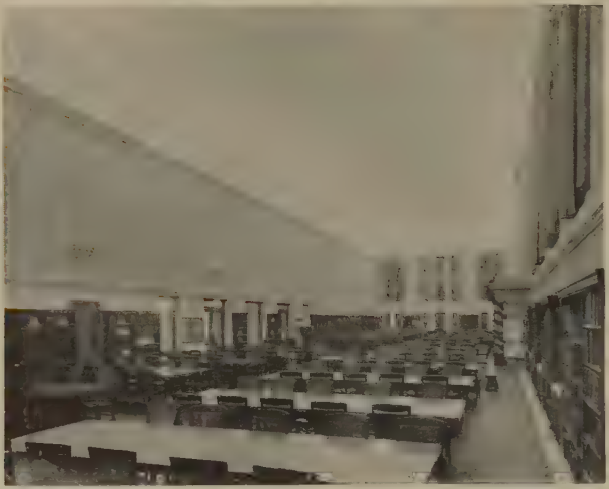


FIGURE 256—Library of Michigan Normal College, Kalamazoo. Malcolmson & Higginbotham, Architects, Detroit, Mich.

used is attractive in appearance, has a soft glow through the glass panels, the brightness of which is about the same as that of the ceiling, thus minimizing any contrast in brightness values that might affect clear seeing.

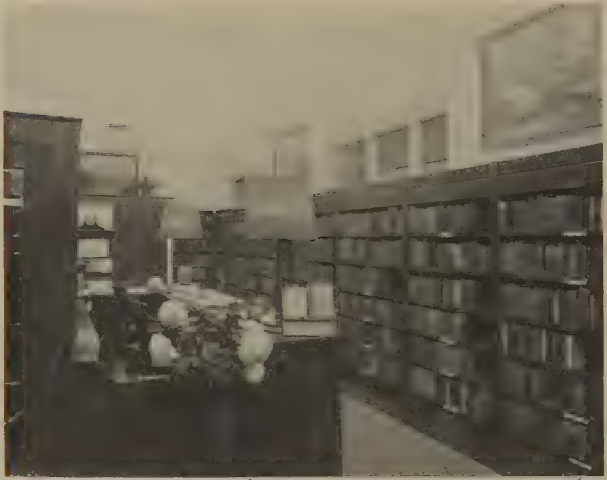


FIGURE 257—Youngstown Public Library, Youngstown, Ohio. Owsley Company, Architects. Equipment concealed in tops of book cases.

For many years lighting conditions in the library of the Massachusetts Institute of Technology in Boston were exactly what may be seen in illustration No. 254, where we find an assortment of table lamps giving concentrated spots of high brightness on the pages of the book. Inadequate general illumination assists in making the worst kind of contrast in brightness, fatiguing to the eye and unsightly from the standpoint of appearance.

Experiments were recently carried on to determine what might be done to correct this undesirable condition, with the result that equipment was installed above the ceiling dome, using a concentrated type of reflector which casts its rays only upon the upper part of the dome from whence the light is reflected throughout the space below, giving truly indirect lighting with the effect shown in Fig. 255.

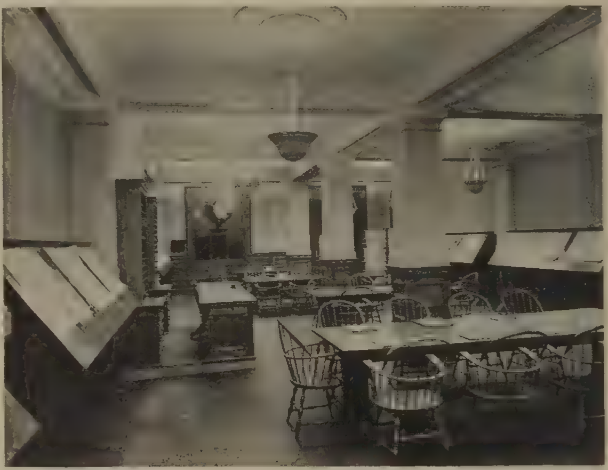


FIGURE 258—A reading room in the Public Library of Milwaukee, Wisconsin.

The units producing the lighting effect are entirely out of the normal range of vision. The table lamps formerly employed are no longer needed and are to be removed. The appearance of the

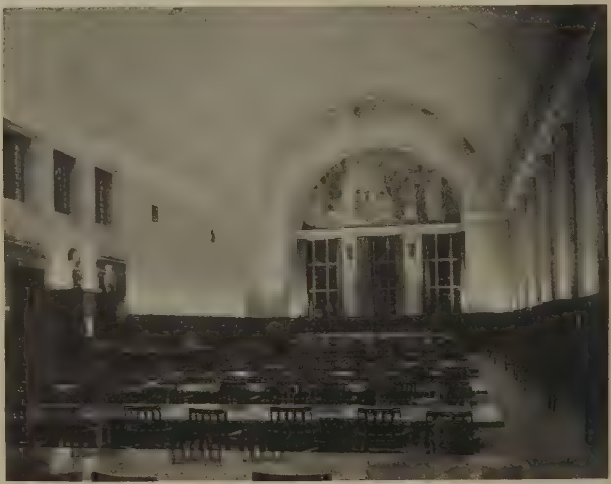


FIGURE 259—Library, University of Michigan, Ann Arbor. Lighting equipment placed in tops of book cabinets.

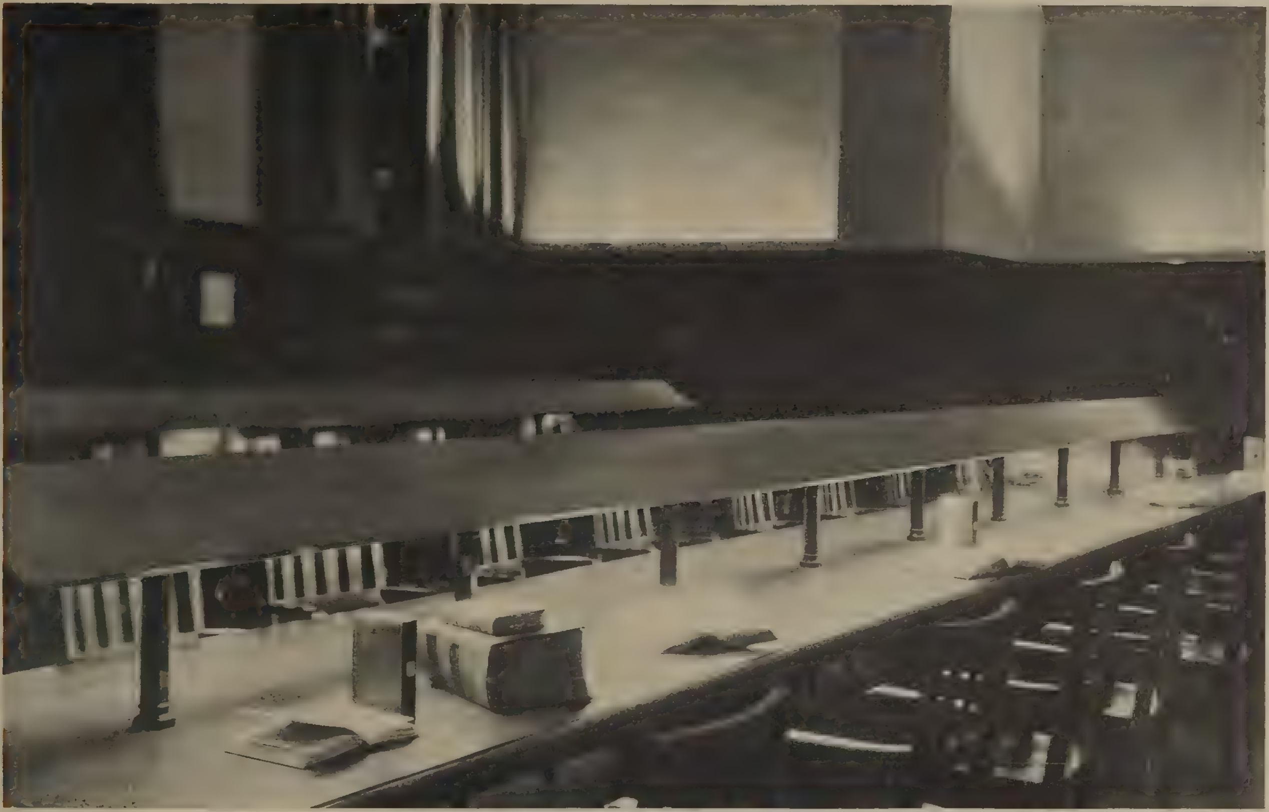


FIGURE 260—Special type of library table lamp in use in the library of the University of Michigan.

room is marvelously improved; the atmosphere of the library is totally different; and the patrons are provided with the maximum seeing comfort.

Although in many libraries the logical method for illumination is in the use of pendant ceiling fixtures of the indirect type, such as shown in Fig. 258, the favorite and desirable method is the concealment of all lighting equipment, as, for example, the library at the Michigan State Normal school, which has a ceiling forty-five feet in height. The cornice, which continues around the entire room, provides a logical place for the installation of cove lighting equipment, and enables an intensity of ten foot-candles to be provided on the reading page at a moderate expenditure for electrical energy. The planning of this type of installation is discussed in part IV, on page 286, and requires closest cooperation of the architect and decorator with the lighting specialist.

Surprising in its simplicity, the Hubbard Square Branch of Youngstown Public Library is a model of completeness and refinement. The lighting is one of the features. Here we find reflectors and lamps concealed along the top of the bookcases, giving a remarkably even distribution and comfortable lighting over the room. In addition, two art lamps equipped with Curtis adapters for indirect lighting adorn either end of the desk. Although small in size, this library embodies the latest principles in lighting and furnishings.

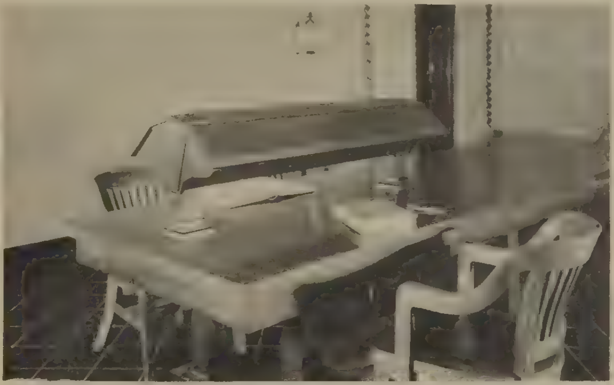


FIGURE 261—Section of reading lamp developed primarily for library tables.

The large reading room, such as we find in our university libraries, involves a distinct lighting problem. A happy solution for one of these is to be found in the library at the University of Michigan. The room is of magnificent proportions, as may be seen from the illustration in Fig. 259. The width of the space is 48 feet, its length 176 feet, with a ceiling 50 feet in height. The table arrangement is designed for about 250 readers.

The illumination of the room comprises two features, a well diffused and glareless general illumination produced by the totally indirect system, having reflectors concealed in the tops of the book cases. In addition to this, a local illumination is produced by a new type of table lamp especially designed by Prof. H. H. Higbie for the installation, giving an illumination of an extremely comfortable quality for reading purposes. A lamp of similar design is shown in Fig. 261, and more in detail in Fig. 264.

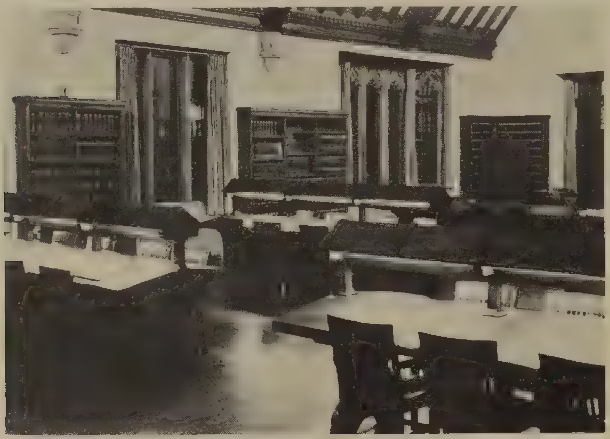


FIGURE 262—Swift Hall Library, University of Chicago. Coolidge & Hodgdon, Architects.

It will be noted by the latter figure that the primary source of light is enclosed in the reflector, which after a series of reflections from the mirrors and diffusing plates, delivers to the table tops an illumination of extremely uniform and glareless quality. The switching arrangement is such that lamps may be controlled in sections and only that portion of the table may be illuminated which is actually in use by the reader.

The height of the bottom of the lamp is such that the only light visible from any point in the room is that which is reflected. The height of the top of the lamp is planned to prevent a general view about the room, thus tending towards concentration of attention.

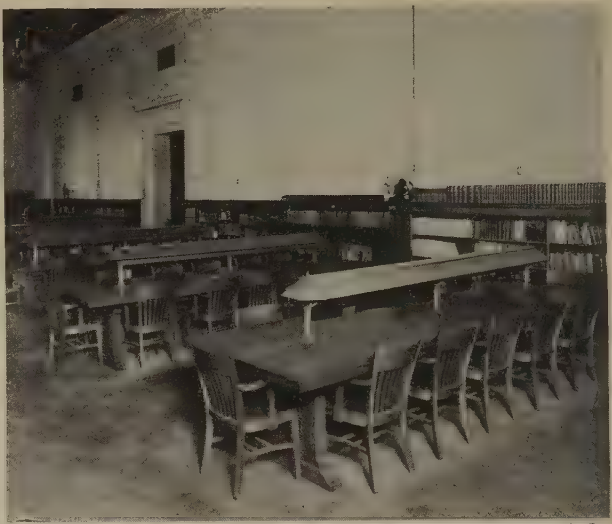


FIGURE 263—Special table lamp as used in the Library of the University of Minnesota.

It will be noted from the illustration in Fig. 259 that the general scheme of lighting not only facilitates the use of the books contained in the library, but also greatly accentuates the magnificent proportions of the room, bringing out its spaciousness, and illuminating with great effectiveness the large mural paintings at each end.

The general lighting is such that titles of the books in the cases are sufficiently illuminated without the aid of auxiliary or gooseneck fixtures

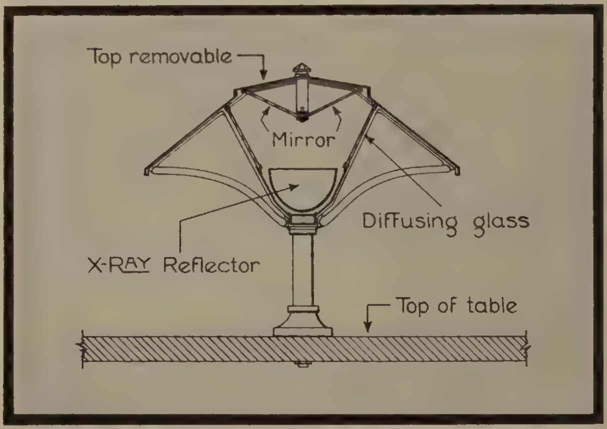


FIGURE 264—Diagram showing the principles involved in the special library table lamp.

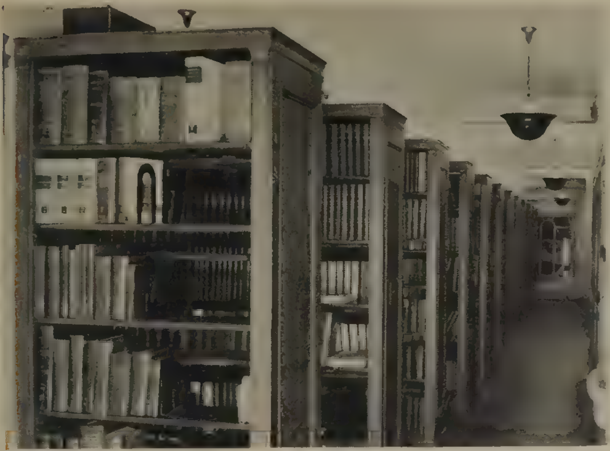


FIGURE 265—Book stacks in the Library of the Mayo Clinic, Rochester, Minn. Ellerbe & Co., Architects, St. Paul, Minn.

projecting from the tops of the cases, which are usually unsightly and do not provide a uniform lighting for both the top and the bottom of the bookcases.

There is frequently an economic advantage in combined local and general lighting, such as was used in this installation. Many readers prefer general illumination, while others are inclined towards the use of a local lighting arrangement; and it is for this reason that the University of Michigan has installed both types.

The miscellaneous departments of the library require good lighting also. The office of the librarian and his assistants should be treated the same as commercial offices. Suggestions may be obtained by referring to page 69. Reference rooms, card index files, periodical rooms, etc., all require most excellent light.

Book Stacks

The adequate lighting of the bookcases has given librarians considerable concern, since it is frequently difficult to read the titles on books in the lower shelves and stacks without removing the volumes for closer inspection.

Various types of lighting have been employed for this purpose, including bare lamps, drop cords, open metal reflectors and glass shades of improper design, all of which have given unsatisfactory service and uneven distribution of light.

Where conditions are favorable the ideal system of illumination for the bookshelves is indirect lighting, as is shown in Fig. 265, for the Mayo Clinic, of Rochester, Minnesota. By judicious spacing of the lighting units uniform illumination can be received in all of the narrow aisles of the book stacks, enabling titles to be read as readily at the bottom of the stacks as at the top.

Many book stacks, however, are built in tiers one above the other, with ceilings of glass or other material unsatisfactory to the use of indirect lighting. In this case some form of directed lighting is necessary, but this should be well shaded and properly diffused. An example of this type of installation is illustrated in Fig. 266, where small unobtrusive lighting units have been employed to give the desired result. The restricted ceiling height, which is usually between six and seven feet, adds to the problem by limiting the selection of the fixture that may be used.

For the Wisconsin Free Library a 25-watt lamp in the "Scoopette" type X-Ray reflector has been installed with eleven units to each stack fourteen feet in length. The direction of light from the reflectors was alternated so that the light of five reflectors is thrown to one stack and the light of six upon the books in the stack on the other side of the aisle. The source of light is in the center of the aisle between the two stacks. The result is an even distribution of light. In walking down the rows one experiences no glare from the units.

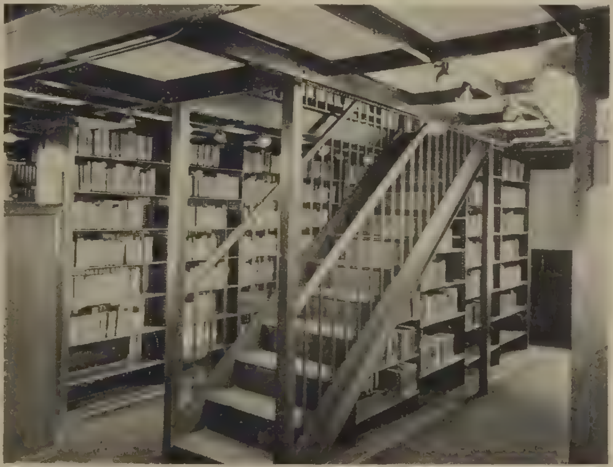


FIGURE 266—Book stacks of the Free Library of Madison, Wis.

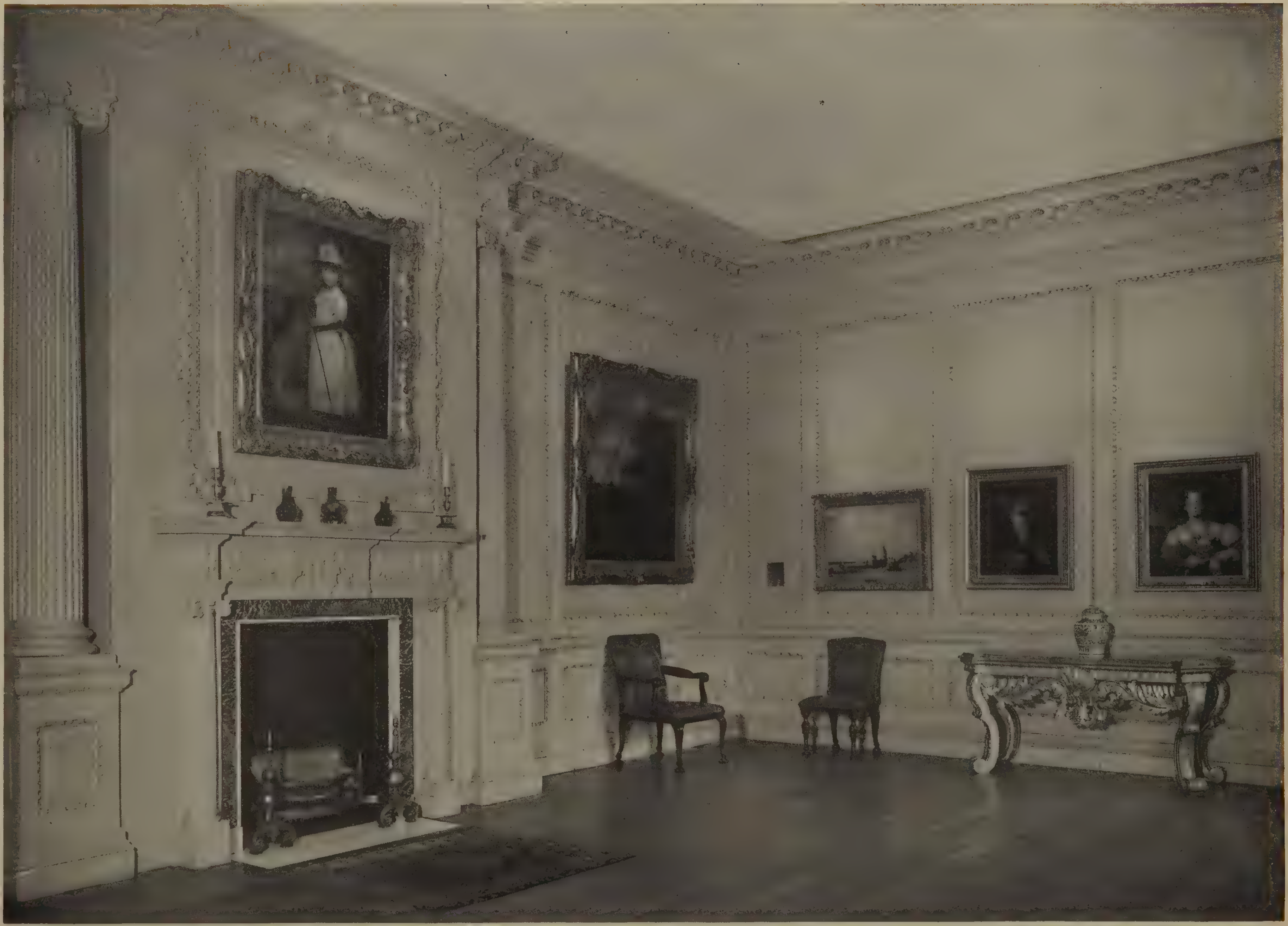


FIGURE 267– The Scarsdale Gallery of the Philadelphia Museum of Art. The associated architects for this magnificent building were C. L. Borie, Jr., Horace Trumbauer, and C. C. Zantzinger.

MUSEUMS

THE WORD "museum" is derived from an old Greek word which means "The Temple of the Muses." In our day, however, the name is associated with buildings in which collections of scientific, literary and natural curiosities or works of art are gathered for their general educational value to the public.

Historical records state that the first structure of this kind was the famous university building at Alexandria, in Egypt, including the large library. The founding of this venerable institution in 283 B.C. is attributed to the ruler, Ptolemy Soter, a patron of the arts.

Except for the one in Alexandria, these institutions remained practically unknown from the fourth to the seventeenth century. The earliest museums had small beginnings, merely aimless collections of curiosities, amassed without method or system, usually by private individuals. It was not until the latter part of the nineteenth century that the modern museum, as we know it, exhibited any appreciable growth or development and established itself as an outstanding public institution, with the definite aim of providing educational facilities and recreation.

Museum buildings, usually of outstanding architectural and cultural value, cannot adequately perform their purpose unless every work of art, every object of historical and scientific interest is clearly visible by an illumination that not only enables the observer to see clearly, but

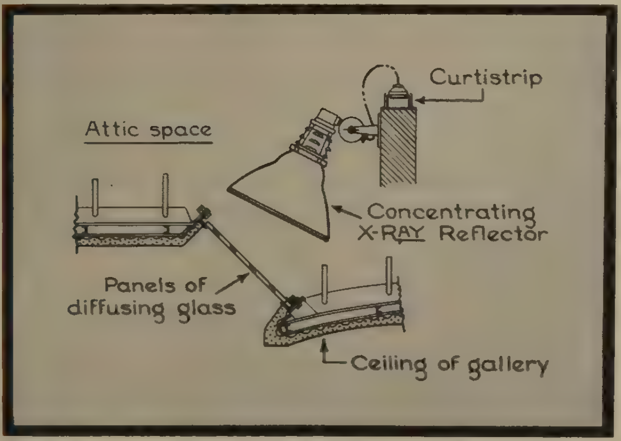


FIGURE 268—Diagram showing type of lighting equipment employed for the galleries in the Philadelphia Museum of Art.

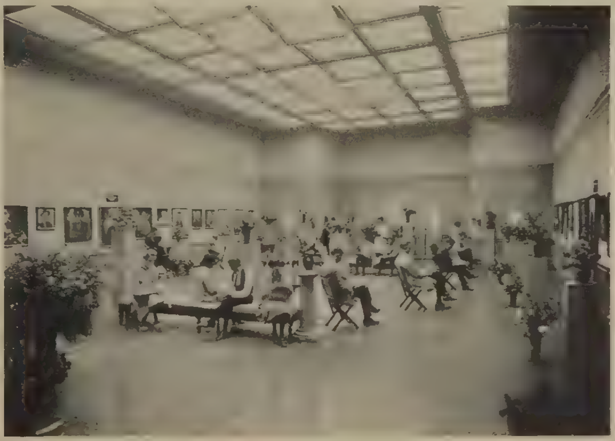


FIGURE 269—Milwaukee Art Museum, Milwaukee, Wis. Light concentrated upon exhibit area comes from skylight units.

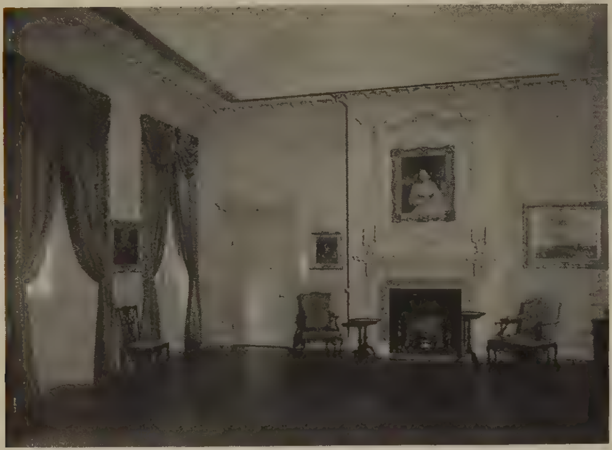


FIGURE 270—Wrightington Hall, Philadelphia Museum of Art. Artificial illumination only is used in the exhibit halls. Daylight has been entirely excluded.

permits of the easy discrimination of fine detail, without eye strain and fatigue.

There are many museums containing exhibits of the world's rarest treasures, secured after many years of travel and research, which have failed to receive the interest and support of the public, largely because of the inadequacy of the lighting provided in the exhibit halls.

Painting Galleries

In providing for the lighting of art galleries where paintings are shown, a few simple principles must be kept in mind. To begin with, reflections on the picture from the source of light must be avoided. To prevent seeing reflected images of objects and spectators in the room on the surface of the picture, these objects and spectators must be in a subdued, reflected light, in contrast to the strong, directed light which falls upon the painting. This may be readily accomplished by the proper arrangement of reflectors, fixtures or other devices used for the illumination.

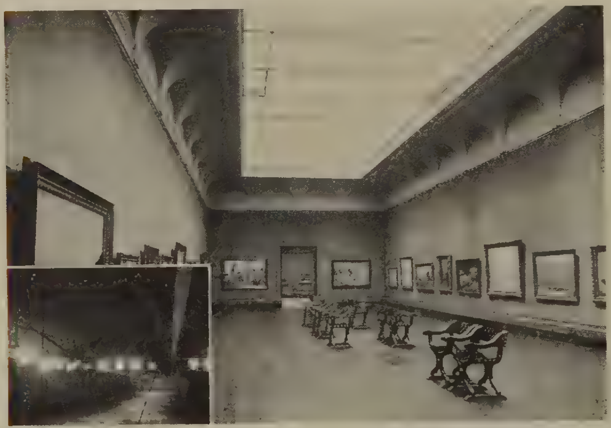


FIGURE 271—The Art Museum of Toronto, Canada. The inset shows the method of illuminating the gallery by means of X-Ray reflectors of special design mounted above the glass ceiling.

Many museums and art galleries have glass ceilings which admit the daylight to the exhibition halls. This method of "top" lighting is used almost exclusively by many architects. The attic space between the sub-skylight and the main skylight gives the illumination specialist much freedom in placing equipment for the artificial lighting, not only for the wall space, but the central area of the room as well.

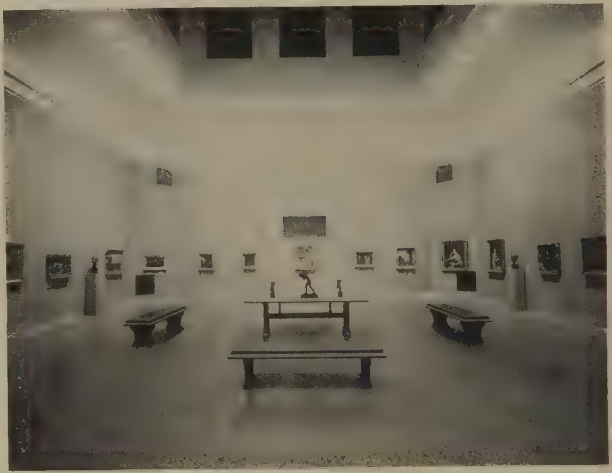


FIGURE 272—Baltimore Museum of Art, Baltimore, Md. John Russell Pope, New York City, Architect, Henry Adams, Consulting Engineer. Lighted from units recessed behind ceiling beams.

On the other hand, a number of important museums have shut out the daylight entirely, since artificial lighting, properly engineered, gives a more uniform result at all hours of the day, regardless of the brightness condition of the sun. One objection to the use of the skylight is that the transmitted radiation tends to make the room warm in summer and causes expensive heat losses in winter. The maintenance of the skylight is expensive, requires frequent cleaning and replacing of glass. Many architects, therefore, are depending entirely upon artificial illumination for all types of exhibits, and feel that they have greater freedom in the design of the building if allowed to exclude the daylight.

Frequently the entire ceiling is not taken up by glass area, the central portion being flat or curved and the side sections provided with small glass panels, above which equipment is arranged so that the light will fall with full brilliancy on the side walls, leaving the center portion more subdued in value. The center portion in this case depends largely on the reflected light from the side wall. When, for the central area, an increase in intensity is desired, indirect luminaires of suitable type may be employed; or a cornice may be designed for cove lighting to give general diffused illumination.

An outstanding instance which exemplifies daylight exclusion is to be found in the Philadelphia Museum of Art. One of the important rooms is shown in Fig. 267 and another on page 158. The means of illumination is effectively concealed from the view of the observer. A method of window illumination is utilized to create an obvious source of light and retain the effect of natural daylight. This arrangement is, of course, not satisfactory for the primary lighting of the room, and hence a system of reflectors was placed above the ceiling around the four sides of the room, mounted behind a band of stippled glass inserted into the ceiling, after the manner shown in detail in Fig. 268. The effect is an extremely uniform illumination over the wall area where the paintings are exhibited, as the reflectors are so designed as to concentrate their beams upon this area. The general lighting of the room is of low value in contrast to the bright walls. The conditions for viewing the paintings in this room are constant, as cloudy or dull days have no influence whatsoever upon the interior illumination. All lamps used are of the so called "daylight" type and tend to exhibit the paintings more nearly in their true daytime color values.

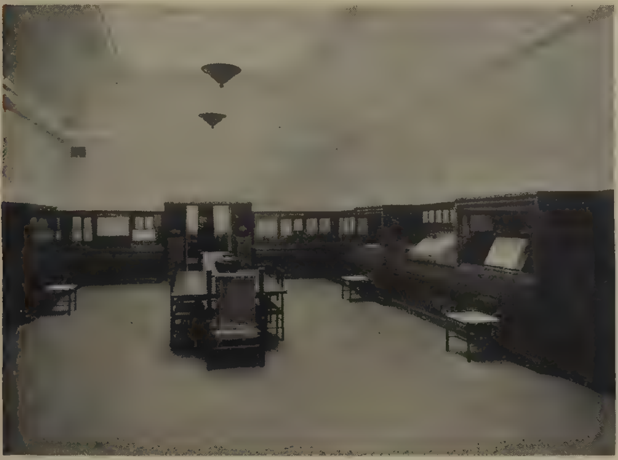


FIGURE 273—Exhibition room, Rohsska Konstslojdmuseet, Gothenburg, Sweden.

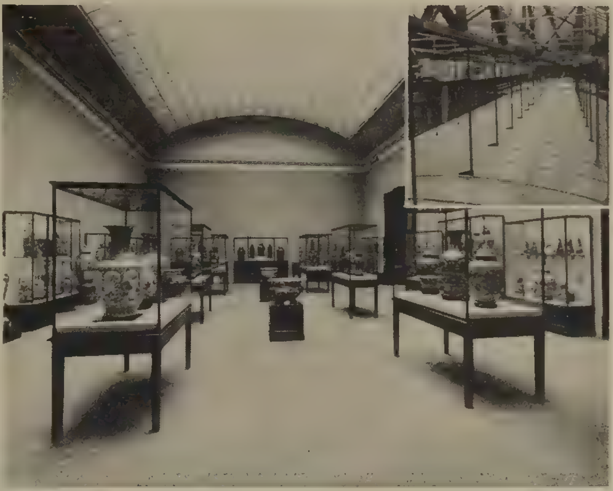


FIGURE 274—Metropolitan Museum of Art, New York City. Inset shows method of illuminating exhibits from above the skylight.

Another installation of interest is to be found in the Balitmore Museum of Art, where a reflector of the concentrating type is recessed behind a hinged rim and lens, with all equipment con-

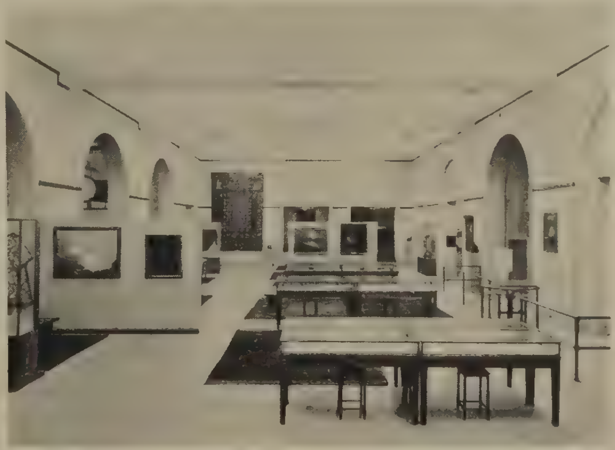


FIGURE 275—Brooklyn Museum of Art, Brooklyn, N. Y. With adequate indirect lighting no auxiliary case lighting is required.

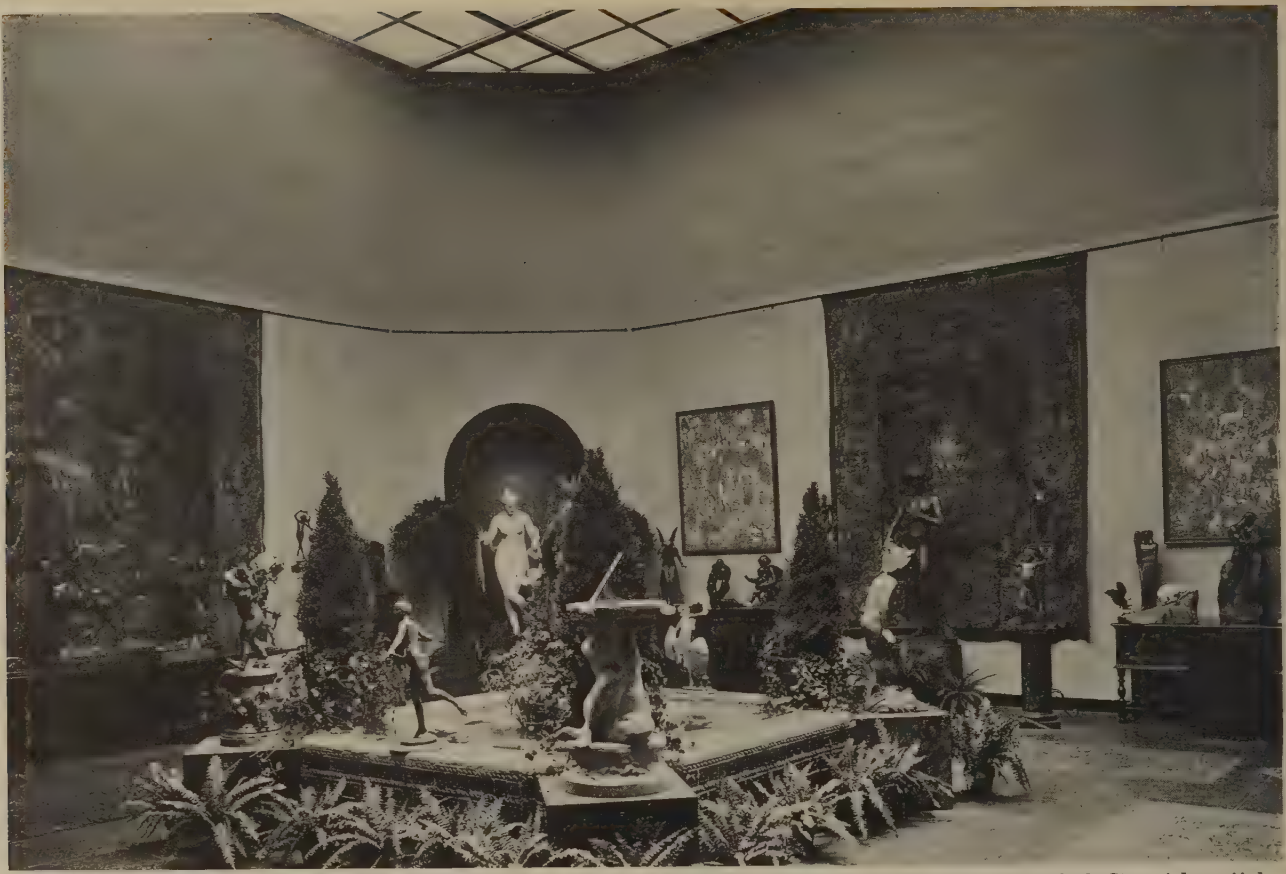


FIGURE 276—Hall for tapestries and small sculpture in the Grand Central Galleries of American Art, New York City. A beautiful illumination effect is in reality indirect lighting reflected from the painted wall of the attic space and filtered down through the ceiling glass.

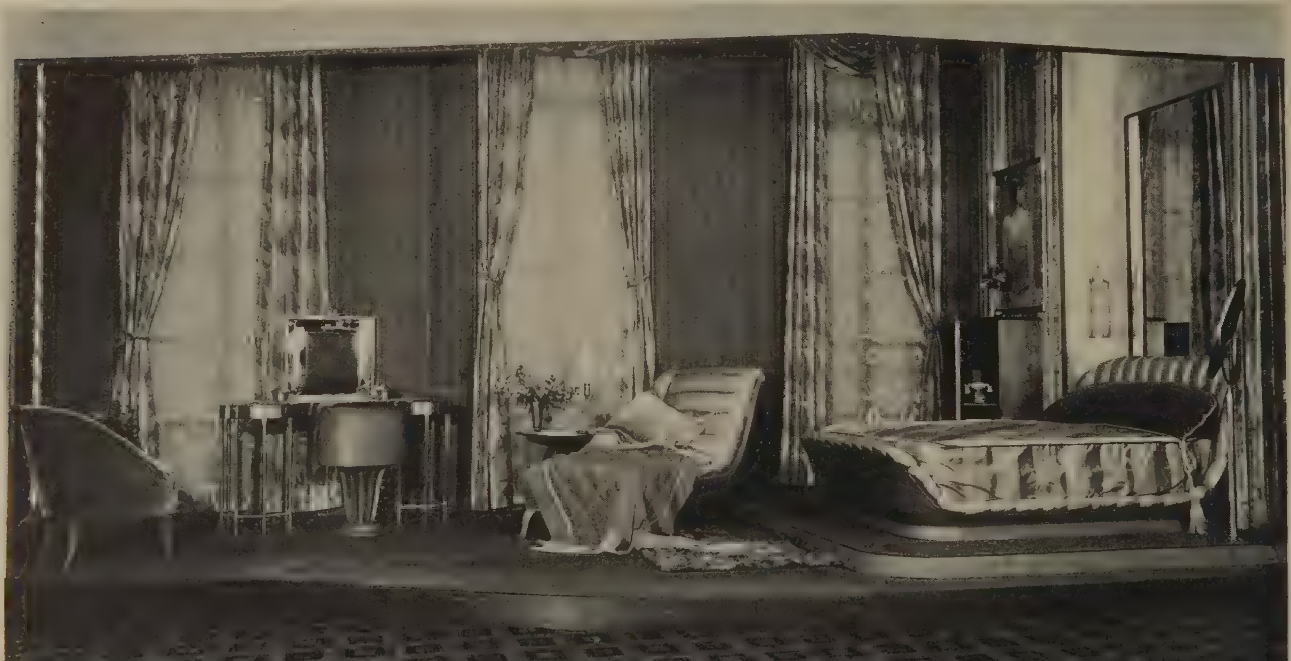


FIGURE 277—A lady's bedroom, a portion of a modern art exhibit at the Metropolitan Exhibit of Art in New York City. The unique lighting was a feature of importance and interest. The room was designed by John Wellborn Root of Chicago.

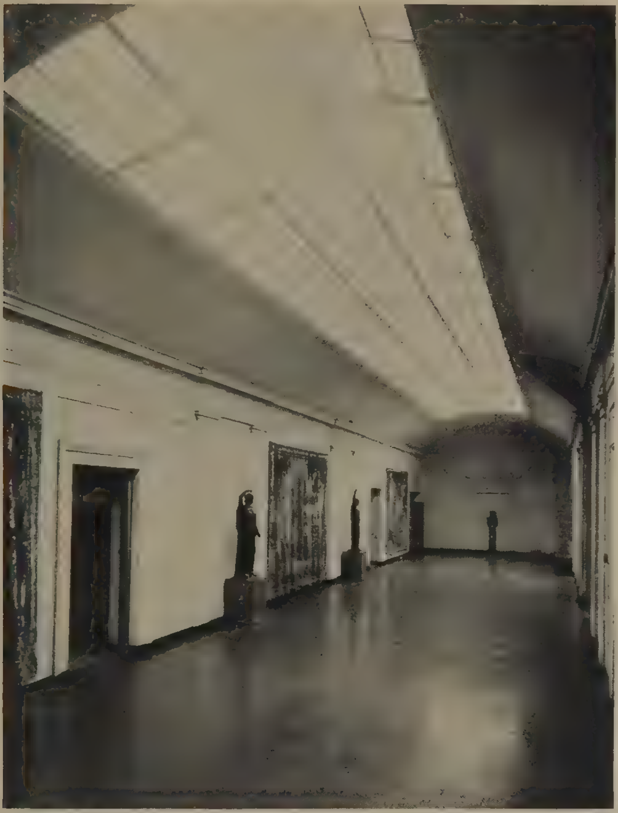


FIGURE 278—The statuary hall of the Goodman Memorial Theatre, Chicago, Ill. The architect was Mr. Howard Shaw.

cealed in special box or housing, which forms a part of the interior trim of the room. In Fig. 272 it may be noted that these units outline the light well in the center of the ceiling area, thus a directional effect is obtained somewhat similar to that of the daylight. The system is an economical one, inasmuch as it utilizes lamps of comparatively small wattage. The results in light delivered upon the exhibition area are greater than for a skylight type of installation, because of the absorption of light that results from passing of the beams through the ceiling glass in the latter type of installation.

General Exhibits

Many of the exhibits contained in museums are shown in exhibition or specimen cases which require either general illumination of good intensity or a localized unit installed on the case, casting its rays through the glass top. Very rarely is it permissible to include the lighting equipment within the case because of the dust-tight construction that is usually employed.

An effective method of lighting the small exhibition room is shown in Fig. 273, a small portion of the graphic art display in the museum at Gothenburg, Sweden. The ceiling glass provides daytime illumination for the room. At night white curtains are drawn under the skylight and their surface used as a reflecting medium for the indirect lighting fixtures suspended below. The effect of the artificial illumination is very similar to that of daylight, giving a high intensity on the horizontal plane as well as on the vertical.

One of the most attractive portions of the Metropolitan Museum of Art in New York is the Pompeian Court, shown in Fig. 279, which has for its masterpieces of sculpture a setting of growing flowers and shrubs. The appearance is that of a formal garden, and lighting has been provided that would emphasize the sense of freedom of the outdoors. The room is large, having a width of 48 feet, a length of 80 feet, and a ceiling 26 feet high. The system of direct lighting includes a symmetrical arrangement of X-Ray reflectors above the skylight, so equipped as to give a uniform intensity of moderate value.

For statuary, shadows and high lights may radically change the expression or mood which the sculptor meant to convey, therefore the lighting of statues must be given much careful

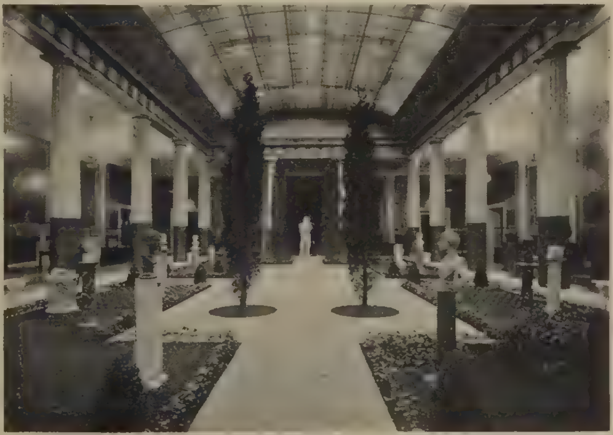


FIGURE 279—Pompeian Court of the Metropolitan Museum of Art, New York City. An outdoor atmosphere is provided by lamps and reflectors above the ceiling.

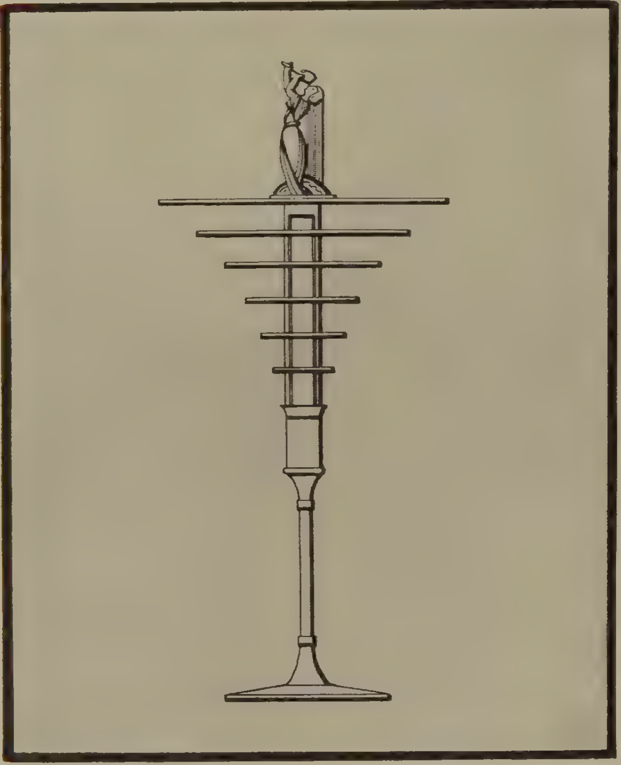


FIGURE 280—A unique lamp was especially designed by the Luminaire Studios for the Metropolitan Museum exhibit shown in Fig. 277.

thought. Although it is not always possible, the ideal method would be to give each subject individual treatment. The importance of proper lighting is emphasized in the comments on "The Appreciation of Sculpture" by the famous artist, Lorado Taft, which in part are quoted in the following statement:

"Soiled casts, poorly lighted, are so disagreeable and so conspicuous that the management (of museums) at last, in desperation, hides them in basement or attic storeroom. Our museums are ashamed of their plaster casts and are trying to get rid of them. It is a great pity, for, if well cleaned and intelligently illuminated, these same pariahs, these leprous beggars, might come again into their own and form the chief treasure of the collection, precious and exalted in their beauty. It is largely a question of lighting, to which no one pays any attention. Properly placed, an electric bulb at an expense of a fraction of one cent an hour is capable of transfiguring a good cast. It will change a 'dead loss' into a radiant asset."

At the recent Exhibition of American Industrial Art in New York we had for the first time in this country a complete series of interiors planned for American conditions by American designers who are intimately acquainted with our needs. Contributions were made by the leading designers, architects and craftsmen in the country, and all exhibits were characterized by individuality of expression, and reflected the dominant elements of our present day culture, activities and thinking. The scheme included the woman's bedroom illustrated in Fig. 277.

As regards the illumination featured for this interesting interior, attention is called to the kidney shaped dressing table with its revolving chair. The table is of pewter, and is lighted from behind through figure silhouettes formed by removing the mirror. Lamps placed behind the silhouette supply all necessary illumination for the table. The same idea is carried out for the large wall mirror. This is illuminated through transparent border designs, which frame it in light. The efficiency of this lighting and that for the dressing table is enhanced by utilizing silvered reflectors for the lamps behind the "cut-outs."

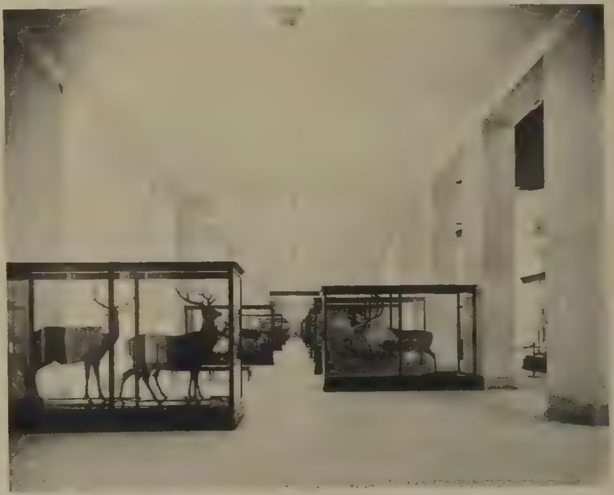


FIGURE 281—The Field Museum of Natural History, Chicago. Graham, Anderson, Probst and White, Architects. An outstanding institution that has provided seeing comfort for the visitors to its halls of rare treasures.

A unique lamp, which stands on a table in the center of the room, is shown in detail in Fig. 280.

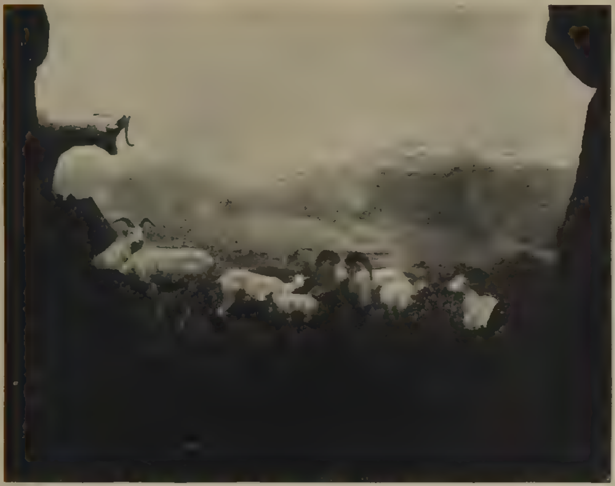


FIGURE 282—A typical exhibit in the Museum of Art, Los Angeles, Cal., designed by the Allied Architects Association of that city.

It consists of a series of horizontal disks perforated in the center and through which a tubular lamp passes. The fixture, which is of extremely unique type, is surmounted by a small female figure. In pewter finish this luminaire harmonizes with the other fittings of the room.

Museums of Natural History

Almost every visitor who comes to Chicago sees the famous Field Museum on the lake front and Grant Park, an imposing structure, ideally situated for its purpose. The lighting of its great halls is a factor that has been given very careful thought and contributes much to the character of the exhibits. Because of the nature and distribution of the displays, the illumination requirements for the building are very different from those in an art gallery, where the light is usually concentrated upon the wall area.

The adoption of totally indirect lighting was at the time of construction of this building somewhat of a departure from the usual method employed for a building of this character, but it has proved particularly desirable for a number of reasons. First, the reflections from a large number of glass surfaces, that ordinarily return bright light points into the observer's eye, are minimized. Again, the displays are viewed from all angles, and well diffused illumination is, therefore, required. The quality and restfulness of the illumination provides greatest seeing comfort for the public. A protracted tour of exhibits in any museum of this nature is physically tiring, and the removal of eye strain is particularly desirable. Furthermore, the diffused system of lighting assists in fulfilling the desire of the architect to obtain the visual effect of spaciousness.

Recently the city of Los Angeles opened the first unit of what will eventually be one of the largest museums in the United States. The building was the design of the Allied Architects Association of that city, comprised of twenty-five of the leading designers of Los Angeles. A committee was selected to study and plan the lighting of the museum, and as the result of their unbiased recommendations an interesting installation was made, using concealed lighting of various types in the different parts of the building.

In the galleries of the North American exhibits, located on the first and second floors of the building, are large, air-tight booths, like those shown in Figs. 282 and 283. One of these contains a large group of buffalo, has a space about 30 by 50 feet, with a slanting glass top. For the lighting of this space sixty-three 500-watt lamps and special X-Ray reflectors are utilized. The light is directed to a concrete ceiling above the glass, thus giving a diffused illumination of uniform indirect quality for the exhibit booth.

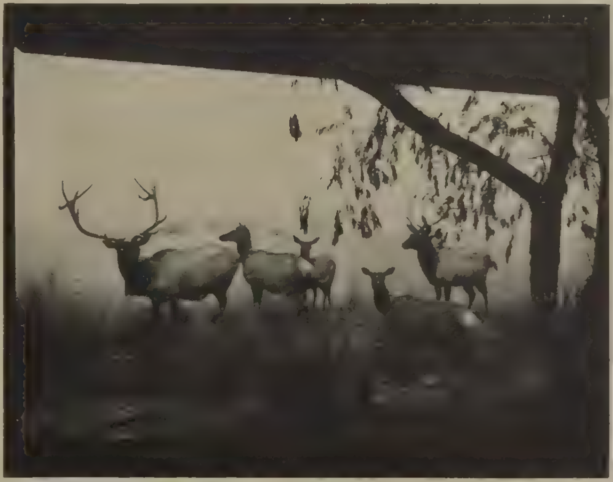


FIGURE 283—One of the exhibit cases of fur-bearing mammals in the Los Angeles Museum of Art. All lighting equipment is exterior to the case.

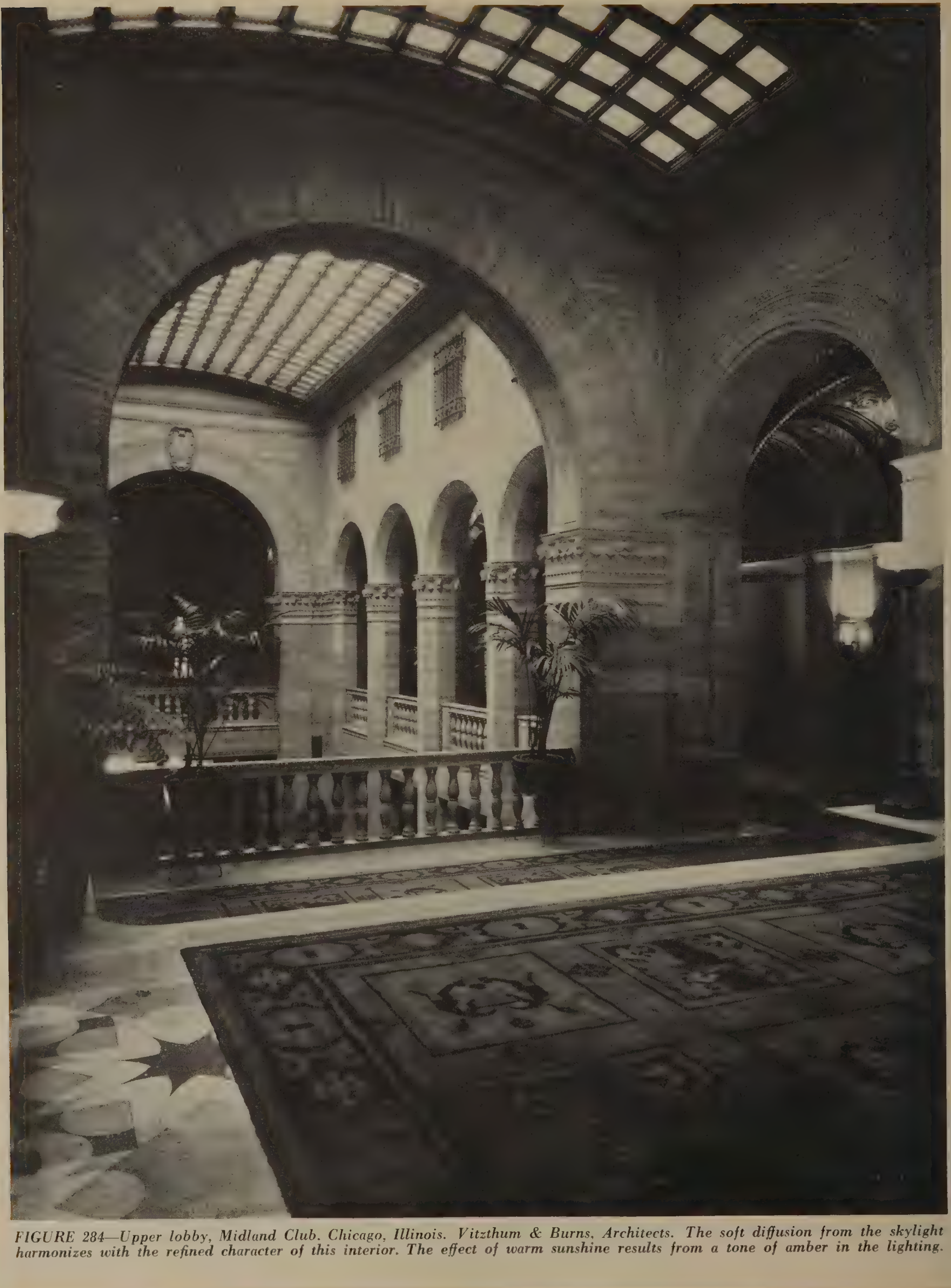
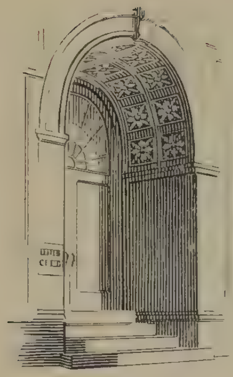


FIGURE 284—Upper lobby, Midland Club. Chicago, Illinois. Vitzthum & Burns, Architects. The soft diffusion from the skylight harmonizes with the refined character of this interior. The effect of warm sunshine results from a tone of amber in the lighting.



CLUBS

EVERY human being is bound to his fellow men by some tie, even though it be a slender one. This common interest, when strengthened and cultivated, forms the basis for the associations of people in organized groups or clubs, uniting the members in some cases almost as closely as by the bonds of kinship. The obvious purpose of our clubs of today is the promotion of social intercourse, although many have been founded for the serious discussion of politics, literature, science and the arts.

It was not until the latter part of the seventeenth century that clubs became either common or famous. The English writer, Addison, was a member of the famous Kit Kat Club, and in the pages of the "Spectator" he refers frequently to the various coffee houses that were the haunts of men of varied tastes, and describes in some detail how the members of every political party, profession and art had their own coterie or club.

Now every center of population has its athletic, business and social clubs, as well as musical, professional, religious and welfare groups. Most of these social organizations are housed in permanent quarters of modest or elegant appointment, depending upon their purpose, prominence, the character of their traditions, or the demands and activities of the membership.

Every department of the club must be well and harmoniously illuminated if it is to be a place of comfort and enjoyment to those who have promoted it and share in the expense of its maintenance. Lighting is the single item that may add more than probably any other feature.

Beginning at the entrance and lobby, the inviting and welcoming spirit of light must be enlisted. Note, for example, the soft diffusion that pervades the upper lobby of the Midland Club, shown in Fig. 284, illustrating how a glareless, harmonizing illumination can introduce a note of quiet restfulness. Here the artificial lighting is

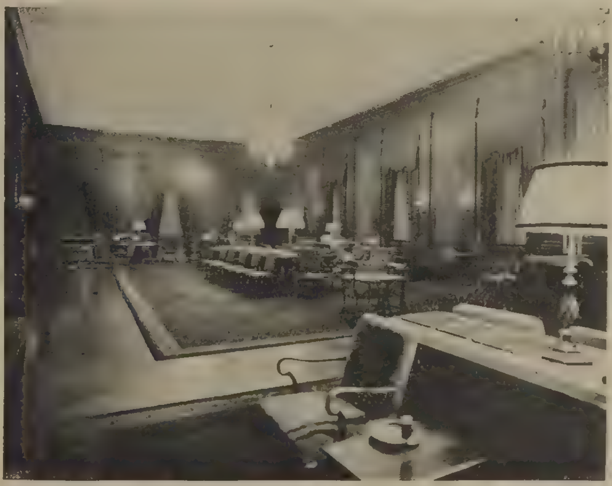


FIGURE 285—Reading room of the University Club, Boston, Mass. The chandelier and wall brackets are decorative. The principal lighting is from the indirect table lamps.

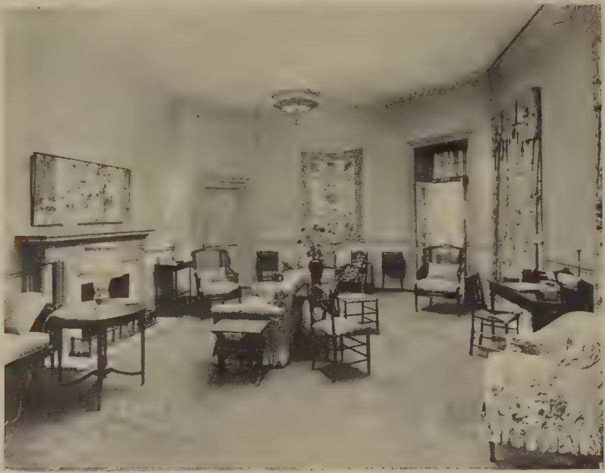
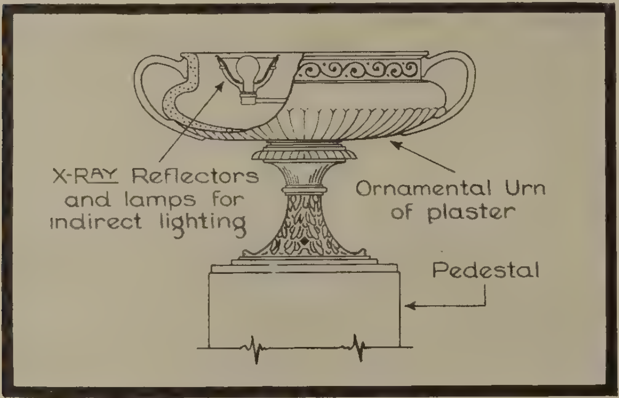


FIGURE 286—Ladies' lounge, Automobile Club, New York City. General illumination from the indirect luminaire is supplemented by art lamps for flexible lighting.

planned to simulate the daytime effect, and comes from X-Ray reflectors and lamps transmitting their rays through a diffusing ceiling of glass. The tint of amber tones the light in a most pleasing and appropriate manner.



X-RAY Reflectors and lamps for indirect lighting
Ornamental Urn of plaster
Pedestal

FIGURE 287—Ornamental lighting pedestal containing reflectors and lamps for indirect lighting. See Fig. 288 for its practical application.

Relaxation in the lounge is a difficult procedure if harsh lighting is there to annoy. Only recently the illumination of the reading room of the University Club of Boston (See Fig. 285) was changed, because the system failed in its purpose. Well designed wall brackets and chandeliers harmonized with the Georgian character of the room, but the glare was present from almost every angle, and in the majority of locations reading was difficult. It was necessary that the glare condition be improved and that more light be added. The illustration shows the effect in the room after the suggestions of the lighting committee were carried out. First of all, the size of the lamps used on the chandeliers was decreased, reducing their brightness very appreciably. The wall brackets were equipped with artistic shades and the table lamps then fitted with indirect lighting adapters of the type shown and described on page 201. It was the latter change that produced a totally different atmosphere in the room, since the table lamps are depended upon for the greater portion of the general illumination. The wall brackets and chandeliers have become incidental in the lighting plan, but furnish a very necessary decorative function. Thus glare gave way to seeing comfort, and the room was transformed by a thoughtful planning.

The ladies' room of the Automobile Club of New York has an extremely "homey" atmosphere, with a general lighting from the indirect luminaire, especially suitable for card playing and small group gatherings. Many times it is not necessary or desirable that the room be flooded with light, therefore some flexibility has been provided. When the indirect lighting is switched off a subdued illumination emanates from the shaded table lamps.

Novel methods are frequently resorted to, as, for example, that pictured in Fig. 288, the prome-

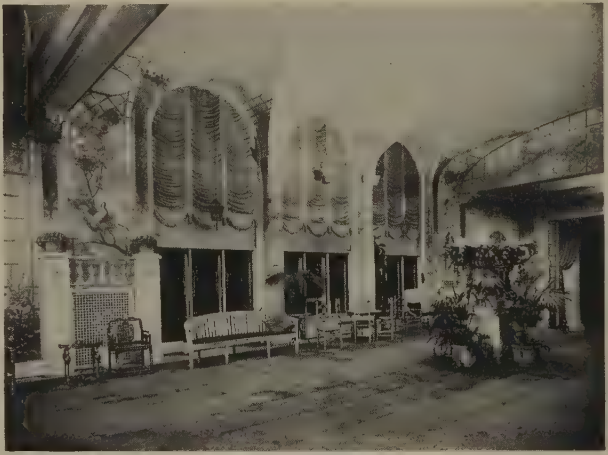


FIGURE 288—Promenade, South Shore Country Club, Chicago. Marshall and Fox, Architects. Light for this space emanates from ornamental floor pedestals.

nade leading to the main ballroom of the South Shore Country Club in Chicago. What is apparently an ornamental urn for flowers hides and houses equipment of the indirect type, whose light reflecting qualities produce a beautiful atmosphere of daylight softness. There is a cheer and warmth about this type of lighting. It has a subtle effect in the displaying of tastefully selected evening clothes. It breaks down the barriers of formality. It is truly the illumination of friendliness.

The ballroom of the club does not always have a ceiling of sufficient height to permit of the installation of large ornamental luminaires. In the case of the Detroit Masonic Country Club the space above the ceiling is utilized for the concealment of lighting accessories, with flush glass plates and hemispheres as the elements for diffusing the light throughout the room. It has been said that variety is the spice of lighting. This is especially true in making provision for the illumination of the modern club ballroom. We, therefore, find that color effects are usually incorporated in the lighting plans, with the frequent addition of a system of Lumitone control, such as described on page 56. Above each ceiling plate in this room is a combination of units for color lighting.

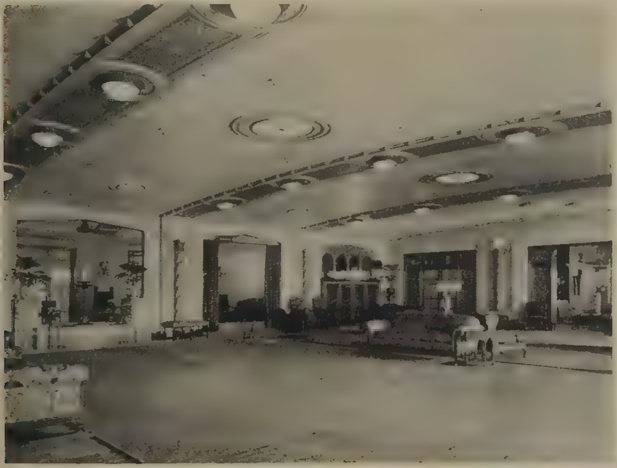


FIGURE 289—Ballroom, Detroit Masonic Country Club, Detroit, Michigan. George W. Graves, Architect. Colored lighting equipment is embedded in the ceiling.

Night clubs, like that shown in Fig. 290, call for something spectacular and unique. Each is an individual problem calling for some imaginative creation in lighting effect.

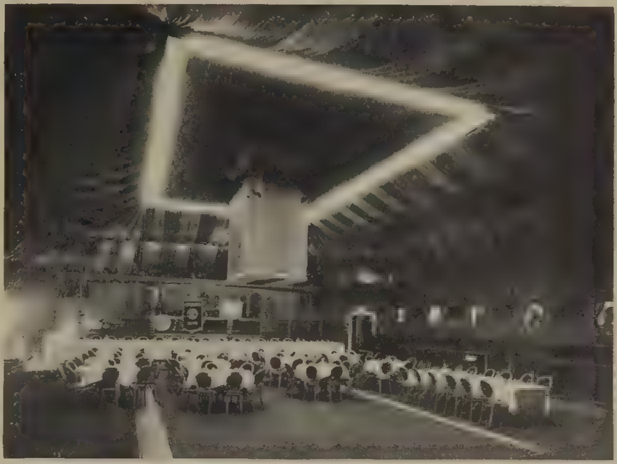


FIGURE 290—A night club designed by Holabird and Root, Architects, Chicago, Illinois. Tinted lighting above the dance floor provides the proper atmosphere.

Additional suggestions for the various rooms and spaces in the club building may be had by referring to the discussion of dining room lighting, on page 181. Recreational facilities must be rationally treated as regards their illumination. Reference, therefore, should be made to page 219 for further information relative to lighting for indoor sports. Library lighting is described on page 151, and notes as to the amount of light to use and specify, as well as methods for planning, are to be found on page 277.

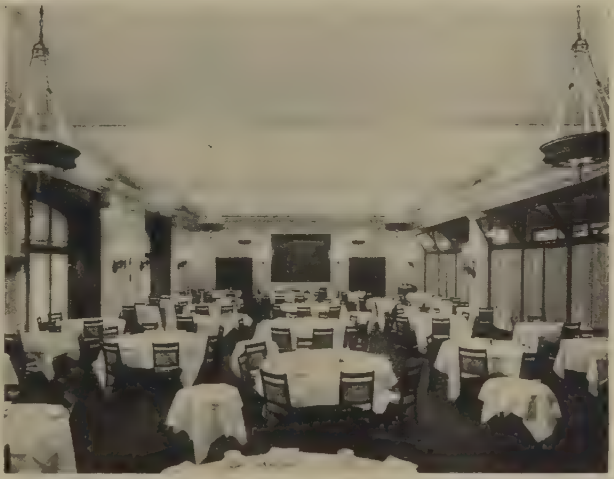


FIGURE 291—Dining room of the Union League Club, Philadelphia, Pa. Gerald Evans, the interior decorator, has provided the room with a generous and restful illumination.

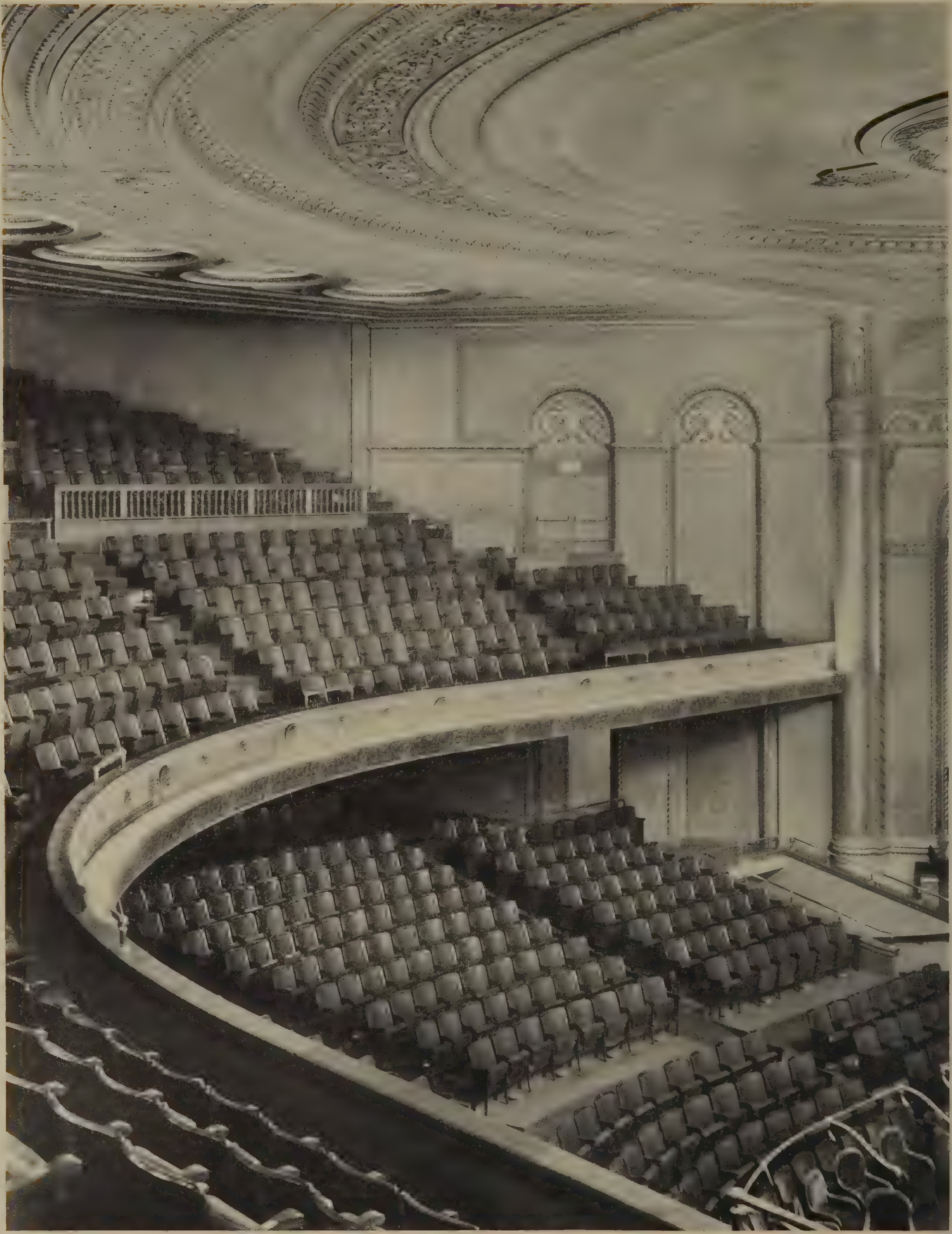
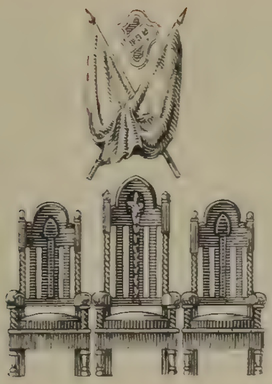


FIGURE 292—Detroit Masonic Temple, Main Auditorium. George D. Mason Company, Architects. George Wagshal, Electrical Engineer. Excellent example of balcony rail lighting.



L O D G E S

THE lodge room, which requires an atmosphere of quiet seriousness, must have furnishings that contribute to this particular mood. The choice of lighting equipment is, therefore, very important as the introduction of glare factors and annoying areas of over-brightness, tend to distract the attention.

Every lodge takes pride in the appearance of its quarters, and proper lighting arrangements add greatly to the attractiveness of the interior. Naturally, every type of room in a lodge building must have lighting that is suited to it. Any one scheme of illumination is not appropriate for all. If subdued lighting is required, that may be easily provided for. If intense lighting is needed, then this may be arranged in the planning of the wiring and installation of luminaries. Where decorative effects are required more elaborate treatment is given, bringing out any particular beauties of decorative treatment, or by embellishment of the lighting fixture itself.

Remarks that have been made by thousands of lodge members indicate that those who have attended meeting after meeting in rooms lighted by various mediums are convinced that diffused illumination, such as produced by indirect lighting, is the most comfortable and lends itself most logically to this type of interior. Under this lighting members may witness in perfect comfort any proceeding without ocular fatigue and drowsiness.

Many beautiful effects are produced by colored lighting, and lodge work accompanied by the changing intensities is very much enhanced in its effectiveness. A subdued glow of light may represent evening, and brighter, more lively sunlight effects be used for high noon. Lighting can, therefore make a great contribution to any lodge room.

A most unusual lighting arrangement is that indicated in Fig. 292 for the Masonic Temple main auditorium in Detroit, Michigan. This fine assembly room seats 4,500, and since it was desired to entirely eliminate any ceiling fixtures of any kind, a special system of lighting from the balcony rail was worked out in cooperation with the architect.

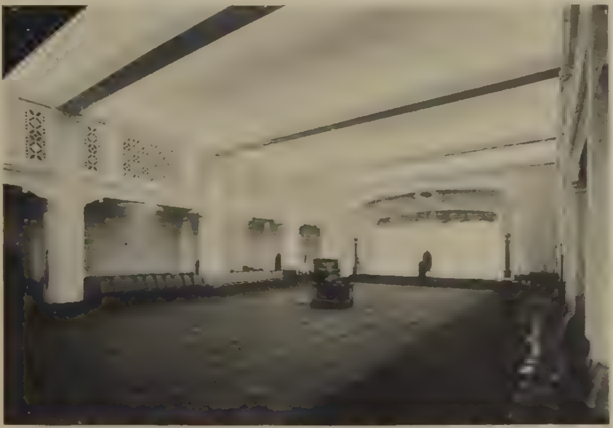


FIGURE 293—Lodge Room, Masonic Temple, Topeka, Kansas. Thomas W. Williamson & Company, Architects.

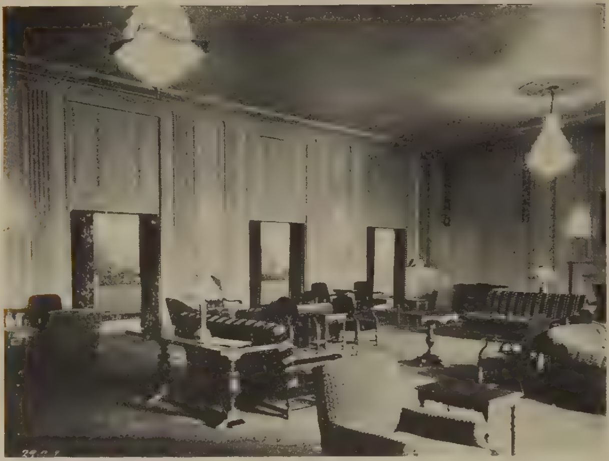


FIGURE 294—Lounge, Masonic Temple, Decatur, Illinois. Holabird & Root, Architects, Chicago. Luminaire of modern design.

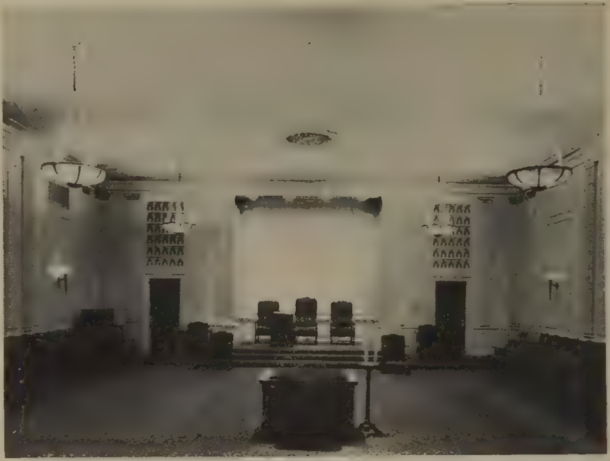


FIGURE 296—Doric Lodge Room of the Masonic Temple, Decatur, Illinois. Holabird & Root, Architects, Chicago.

The architect very cleverly extended the lower portion of the balcony front, forming a compartment in which X-Ray reflectors are concealed. The opening through which the light emerges is covered with glass to improve the appearance, and also to simplify the maintenance.

The light which comes from the reflectors is directed towards the ceiling, which is evenly illuminated, as will be noted from the illustration. This lighting plan takes care of the entire balcony and front main floor section, being supplemented by under balcony lights and also some small units above the rear of the balcony.

Another system that utilizes very successfully the architectural elements of the room is that shown in Fig. 293, the Masonic Temple at Topeka, Kansas. In this case the ceiling is divided into rectangular panels by means of beams which are rather deep. The proportions of the beams are such as to make it possible to install reflector equipment without enlarging the beam in any way or destroying the architectural proportions. If this room were to be equipped with ceiling fixtures suspended from the center of the panel, the effective height of the room would be very much reduced, apparently, to the observer.

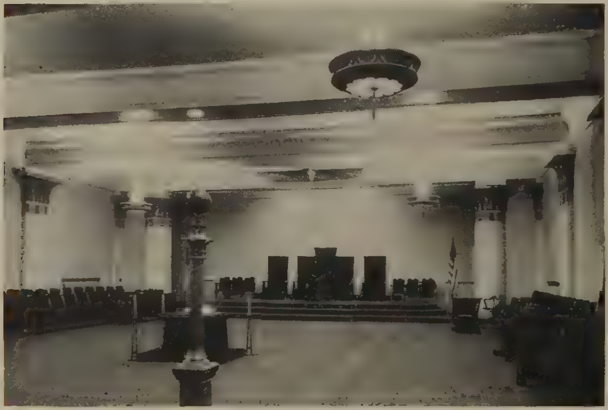


FIGURE 295—Main Lodge Room, Masonic Temple, East Cleveland, Ohio. H. M. Morse Company, Architects.

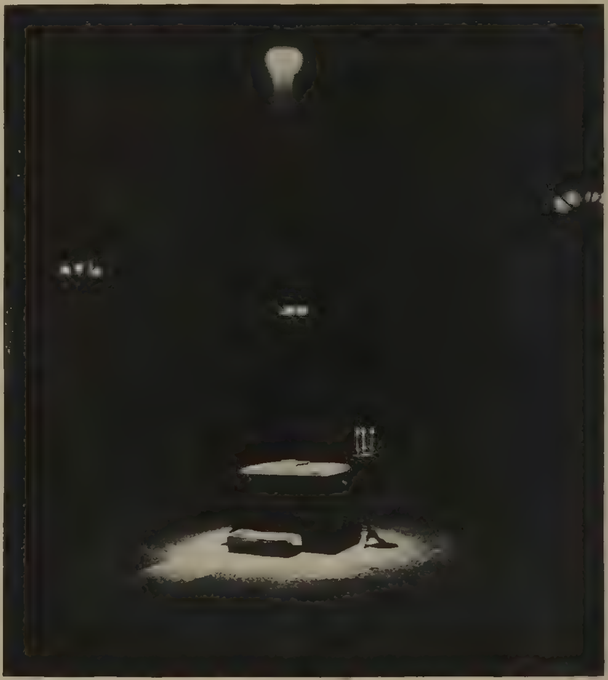


FIGURE 297—Spotlight on altar in Decatur Masonic Temple. Equipment entirely concealed from view in the ceiling.

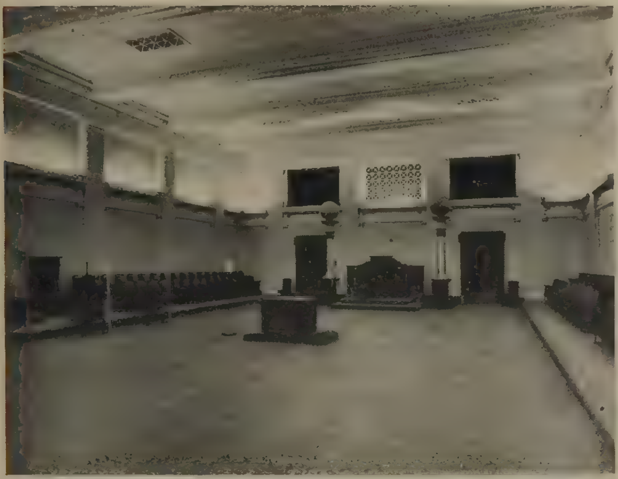


FIGURE 298—Lodge Room, Masonic Temple, South Bend, Indiana. Eugene Osgood, Architect, Grand Rapids, Michigan.

It will be noted that in almost all of the examples of lodge lighting illustrated there is a tendency towards the use of a luminous fixture, one that indicates the source of light; and where the fixture is not employed cove lighting methods are most to be desired. The lodge room in Fig. 295, for example, has a luminaire in composition designed in Egyptian to harmonize with the interior.

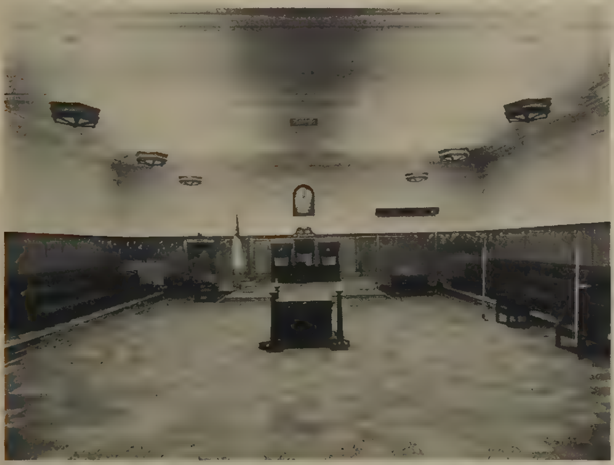


FIGURE 299—Main room of Carsons Lodge, Chicago, Illinois.

The Doric room of the Decatur Masonic Temple shown in Fig. 296 has lighting arrangements that are very complete. The ceiling fixture itself is of plain design to harmonize with the decorative treatment. Above the platform at the end of the room special lighting is provided, using four units embedded in the beam, to be switched on at the proper time during ceremonies.

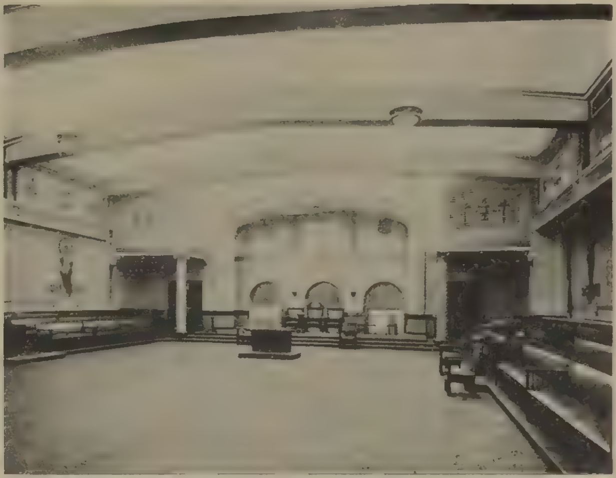


FIGURE 300—Midway Masonic Temple, Chicago, Illinois. This large area uses the luminous indirect fixture.

Note particularly in this illustration, and also that of Fig. 295, the provision that has been made for the lighting of the altar by a concentrated spotlight unit embedded in the ceiling.

The effect of this spotlight is illustrated in Fig. 297, when the room lights by dimming have been very much subdued in value. The method of installing the unit is such as to make the equipment scarcely noticeable.

It is the faithful and intelligent handling of lighting equipment that makes the lodge room a beautiful and restful interior. Any room can be

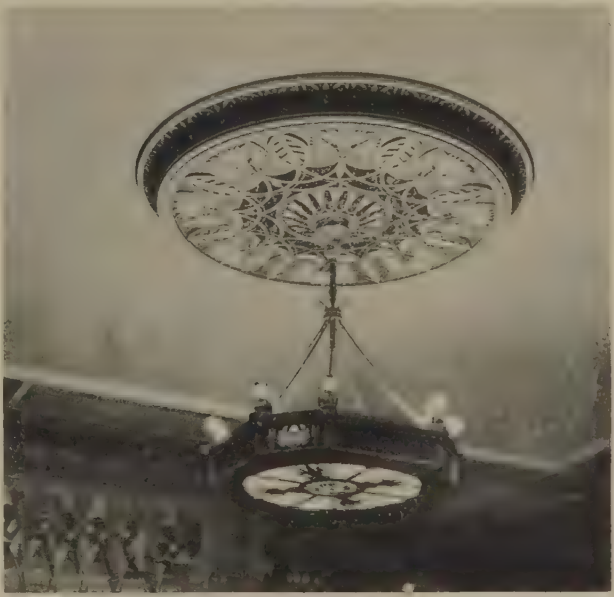


FIGURE 301—Special Egyptian fixture installed in Murat Temple, Indianapolis, Indiana. Rubush and Hunter, Architects.

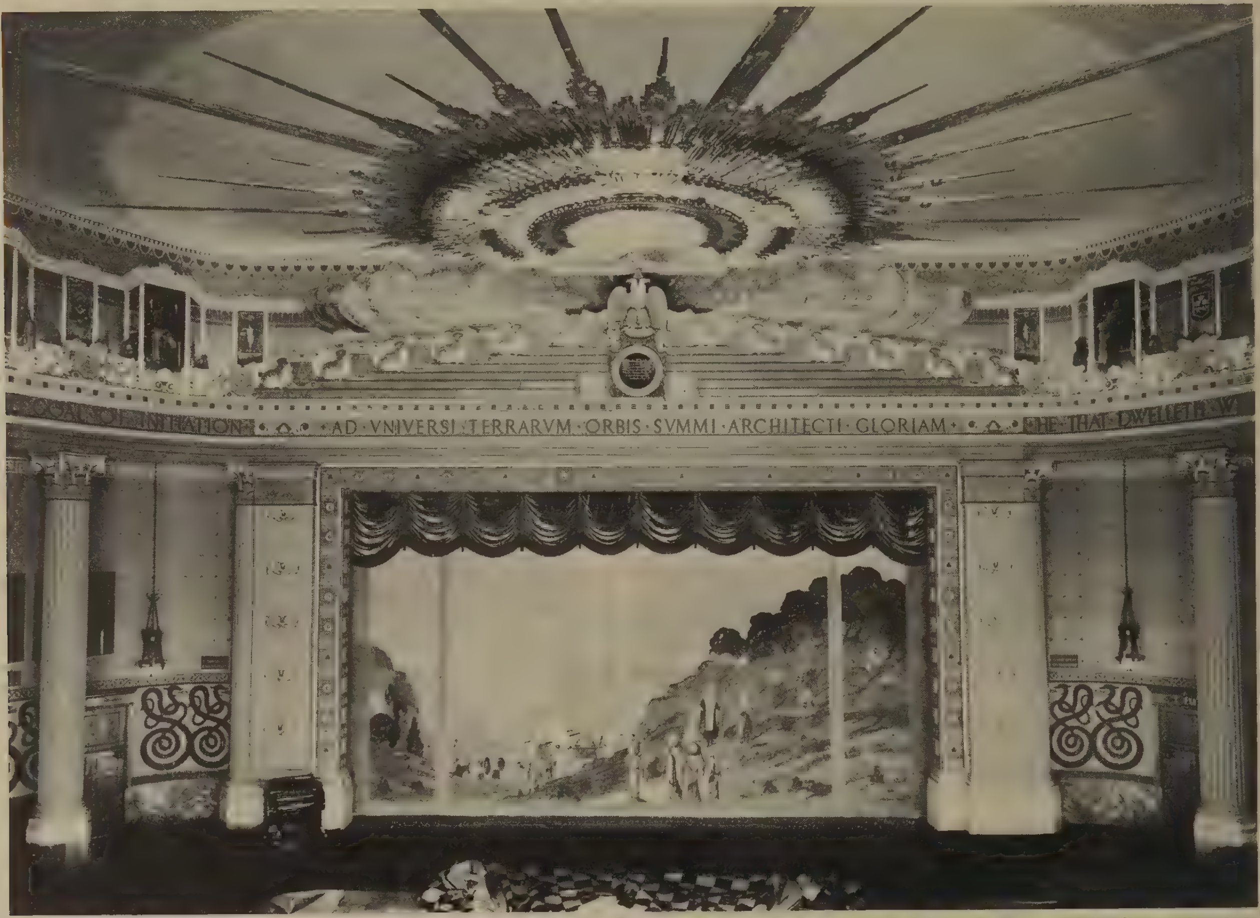


FIGURE 302—Consistory at Buffalo, New York. Harold Jewett Cook, Architect. Robertson Electric Company, Contractors.

made commonplace by the unwise selection of its lighting arrangement. One of the interesting features of the indirect lighting method for lodges is this, whether a room be of modest character or very elaborate in its appointments, the same quality of illumination may be received from a simple fixture as from an expensive and highly decorative luminaire.

From the standpoint of luminaire design the fixture installed in the beautiful Egyptian room of the Murat Temple at Indianapolis is of interest. The fixture is shown in Fig. 301. It is of a special indirect type six feet in diameter. The art glass panels in the bottom of the fixture are of various colors, with amber predominating. For effect and for certain ceremonies a scarab design has been made in green and fitted into the glass panels in the fixture. By means of a metal drum, light shines down through this design independent of the other illuminating features of the fixture. At the top of the bowl in each of the eight

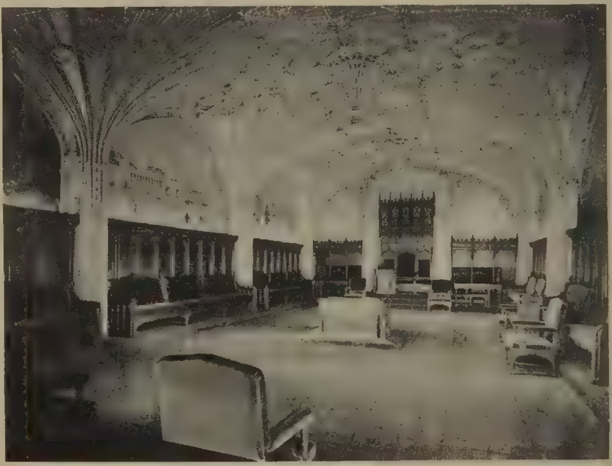


FIGURE 303—Special Lodge room, Ivanhoe Masonic Temple. Kansas City, Mo. Charles A. Smith, Architect.

corners are placed green glass sphinx heads. Each head is lighted from a lamp controlled by flashing socket, which causes the light within the heads to blink on and off, giving a rather unique effect.

As an example of the highly decorative treatment of the lodge building the example shown in Fig. 302 is given. It is the Consistory at Buffalo, New York. This beautiful interior has an elaborate decorative scheme, which incorporates a large central sunburst on the ceiling. Concealed in the various elements of the sunburst are reflectors and lamps which cast their light upon the ceiling area and produce the lighting effect that is seen in the picture. The sunburst is suplemented by equipment behind the decorative frieze around the room. The entire scheme is one designed to give not only comfortable illumination, but to emphasize the artist's treatment of the interior of the room.

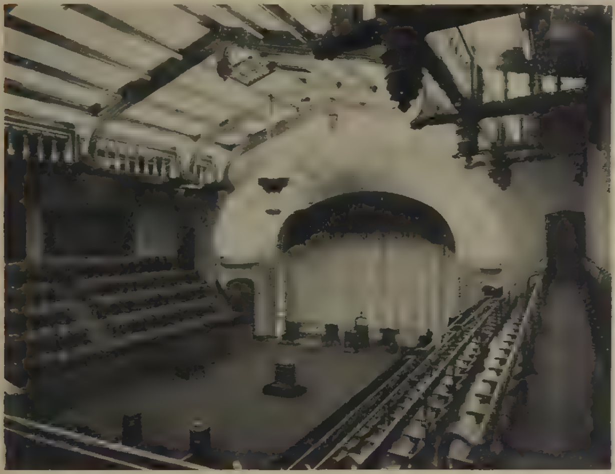


FIGURE 304—Consistory in the Masonic Temple of South Bend, Indiana. Eugene Osgood, Architect, Grand Rapids, Michigan.

The special lodge room of the Ivanhoe Masonic Temple at Kansas City has a system of cove lighting in three colors controlled by dimmers. The room has been designed in Gothic and lends itself particularly well to this type of lighting treatment. The lamps and reflector units are mounted on CurtiStrip between the columns around the entire room seven feet from the floor just at the top of the wall paneling, thus giving a remarkable opportunity for obtaining uniform light over the ceiling area. Fifty watt lamps, placed four inches apart, are installed in a special reflector designed for close spacing.

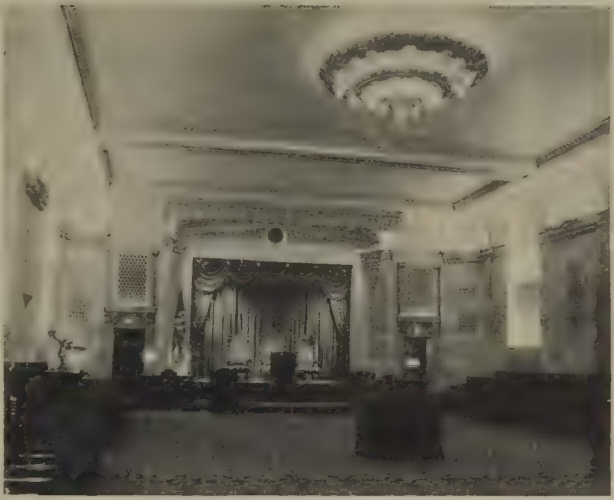


FIGURE 305—Main Lodge room, B. P. O. Elks Lodge, Fresno, California. Kumpf and Johnson, Architects.

The new home of the Elks Club in Fresno, California, embraces the latest and most approved design in wiring and lighting equipment. The main lodge room shown in Fig. 305 has a suggestion of the modern in its design. A stage is located back of the presiding officer's station, while at the opposite end is the organ loft. Deep niches, like false windows, set in the walls lend a cathedral effect to the room, especially when they are illuminated with changing colored light.

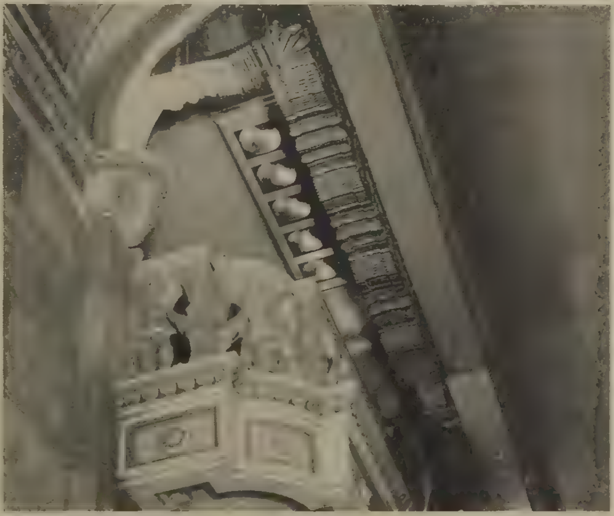


FIGURE 306—Illumination for organ balcony, B. P. O. Elks Lodge, Fresno, California.

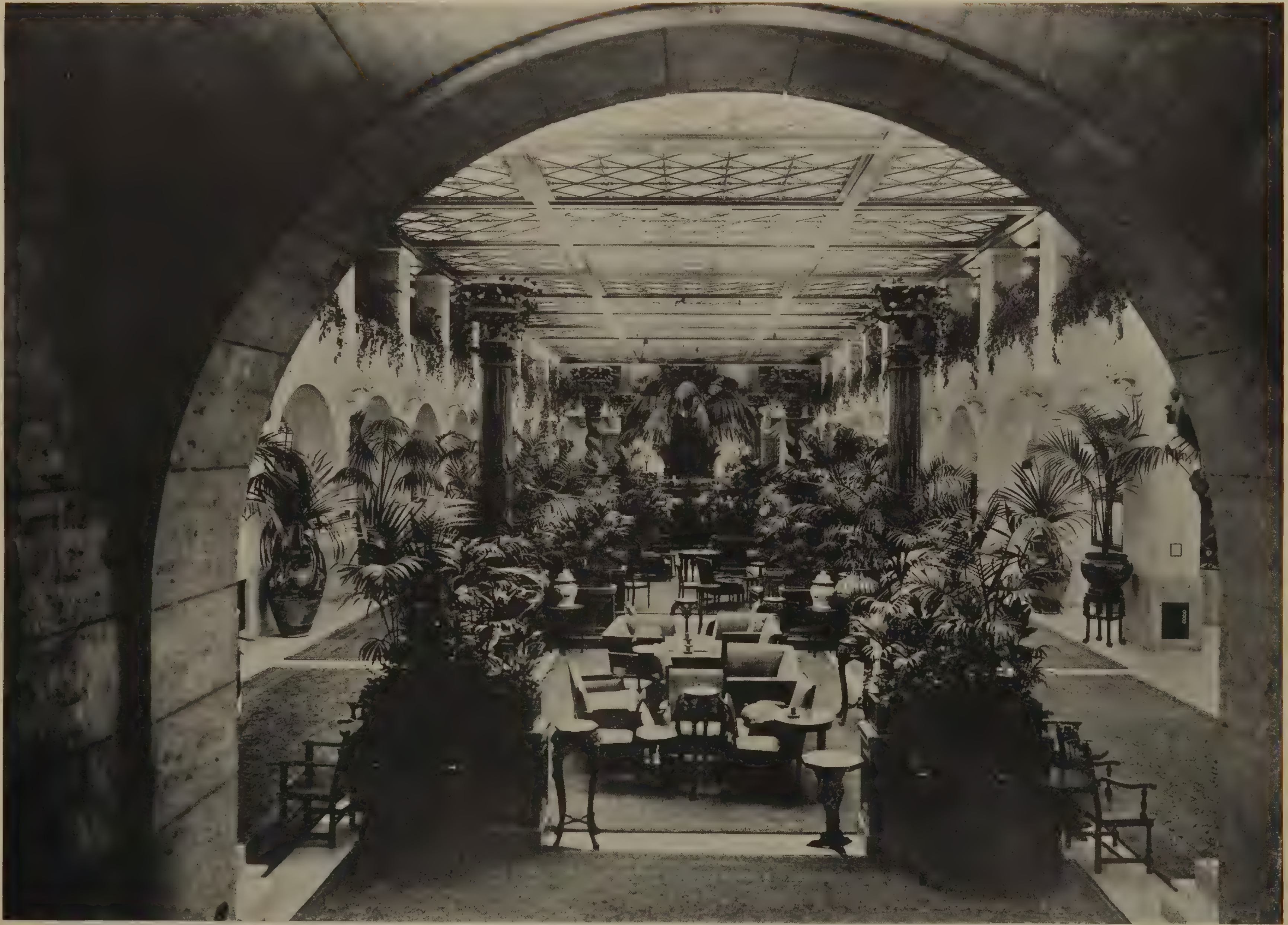


FIGURE 307—The lobby of the Commodore Hotel in New York City. Lighting pedestals and wall urns completely house and conceal the reflectors that supply the illumination for this Italian interior.

HOTELS

SERVICE, comfort and beauty must be the composite offering of the modern hotel in these days of highly specialized competition. To meet the present critical standards the outstanding hotel must excel in every appointment and offer the superlative in service. As a consequence, we find that even in the smaller cities accommodations are provided far in excess of the wildest dreams of twenty-five years ago. During the past few decades hotel service has been developed to a high point of efficiency, so that the increasing of the beauty and comfort of an establishment now remains the chief feature of competition.

In the days of the friendly old inns and taverns the guest was given the best illumination the times afforded, the warm and welcoming cheer of the radiance from the great fireplace in the public room, and as he retired for the night a taper to light him to his chamber. Surely the guest of the present day is equally entitled to the best light that our progressive times may afford; but we sometimes question whether or not he is much better off, comparatively, than the taper-bearing guest of Johnson's day.

The traveler remembers with much pleasure the hotels that are comfortably lighted, because these commercial houses must be his home when he is away from his native city. It is particularly important that the lobby and guest rooms be illuminated to produce an inviting, restful atmosphere. Here the guest receives his first favorable or unfavorable impression, an impression that is frequently a lasting one. Every guest does not endeavor to analyze why the room is attractive or unattractive, but he will have a reaction that may determine whether or not he returns at some future time. Harmony in the lighting arrangement will produce a decided psychological effect upon the patron, since he unconsciously judges the age and quality of the hotel by its illumination methods. Harmonious lighting involves not so much the number of lamps or the amount of wattage employed, but the manner of distributing the illu-

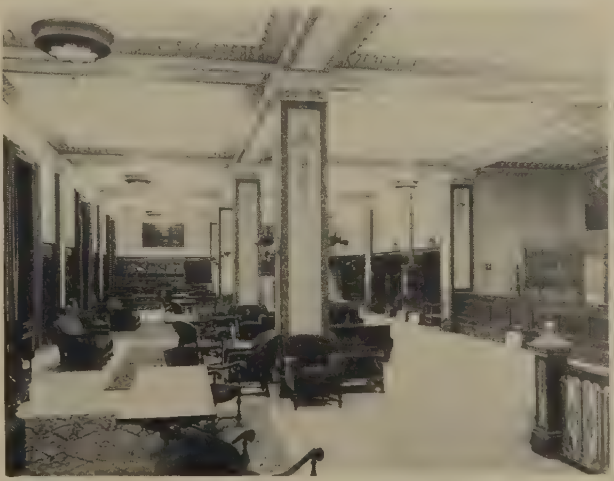


FIGURE 308—Lobby of the Jayhawk Hotel, Topeka, Kansas, is typical of American hotels appropriately lighted with luminous bowl indirect luminaire.

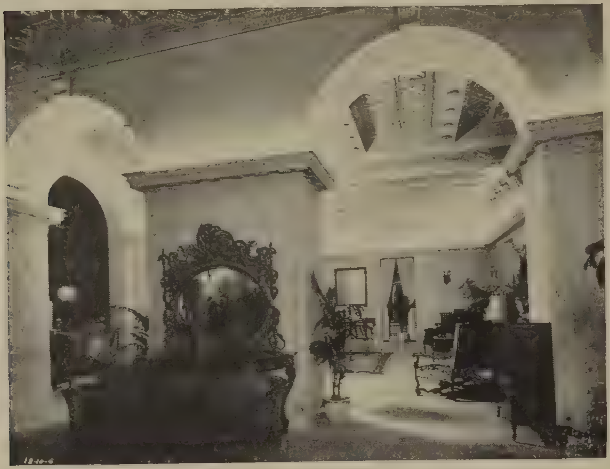


FIGURE 309—Corner in the lobby of the Carlton Hotel, of Washington, D. C. M. Mearobiau, Architect, was the designer.

mination throughout every corner of the room.

Our great public, either on business or pleasure bent, often finds that many of our best hotels combine a woeful lack of proper application and adequate understanding in the lighting system, although in their general design much thought has been given to the comfort and convenience of the guest. The most frequent and flagrant violation of important lighting fundamentals lies in the persistent omission of shades for the lighting source, a practice undesirable from the artistic standpoint, and disturbing and distracting to the complete comfort of the guest.

The lobby of the Commodore in New York, illustrated in Fig. 307, is the principal show feature of that hotel. It was designed by the architects to represent a great Italian garden or courtyard. The lighting problem, therefore, called for careful study and necessitated an unusual kind of treatment. The whole scheme was devised to fit the architectural requirements of the room. Since in an Italian garden there is no legitimate place for lighting fixtures of the ordinary hanging type, they were entirely omitted in this room and the illumination obtained by other means. One might expect, in a garden, to find the principal illumination coming from the sky, hence to carry out this idea a glass ceiling was incorporated. No daylight enters the room through the ceiling. The light, emanating from ten floor pedestals and twenty gargoyle wall brackets, is directed to the glass ceiling and reflected from it. The framing is carried out in very dark tones, so as to reflect only a small portion of the light, giving the illusion that the glass panels only are luminous. The urns and pedestals for the lighting are ingeniously placed among the furnishings of this elegant interior.

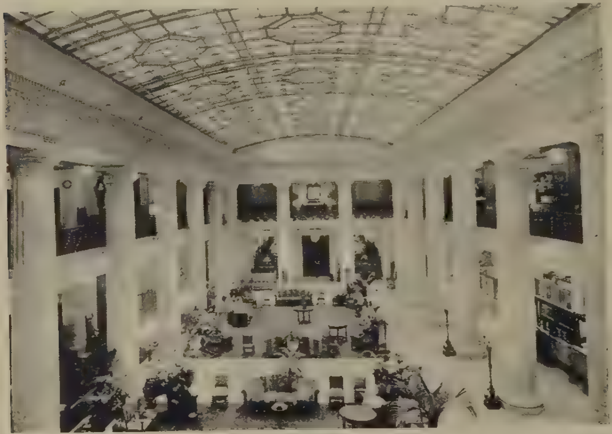


FIGURE 310—Lobby of Pennsylvania Hotel, New York City. The skylight system is particularly effective here, supplemented by well shaded and decorative floor lamps.

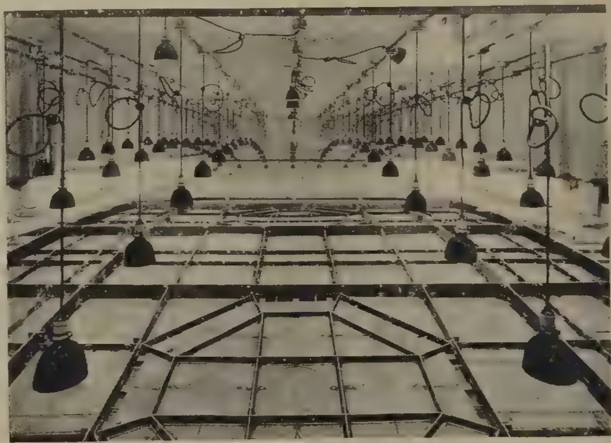


FIGURE 311—Manner of illuminating lobby of Pennsylvania Hotel by reflectors disposed over skylight area.

The size of the hotel, the type of architecture and general appointments have a very decided bearing upon the type of lighting to be installed. In Fig. 308 we find pictured the lobby of the average sized hotel, with spaces for offices, reading and writing. The decorations are usually not as elaborate as for the great city hotel, and therefore a complex system of lighting would be entirely out of place. The illumination received from the luminous indirect fixtures is of the same restful quality as would be obtained from an intricate system of concealed lighting. The luminaire is harmonious in its design, and the lighting results meet with all the requirements for this type of interior.

In contrast to the lobby of the Commodore, the Pennsylvania Hotel has a skylight constructed of silver rippled glass of an amber tint. This ceiling admits the daylight and is depended upon for the natural lighting of the room. It was the desire of the architect to obtain after dark the daytime appearance, as nearly as possible. Reflectors and lamps were, therefore, placed above the glass. Inasmuch as the type of glass selected is not particularly dense, it was necessary to use a large number of small units to prevent a spotted appearance caused by unequal brightness values. The method of installation is illustrated clearly in Fig. 311, where a small type of X-Ray reflector is shown, spaced on comparatively close centers.

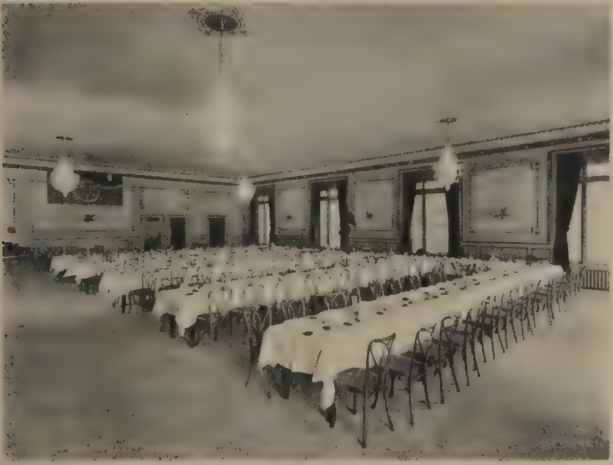


FIGURE 312—Dining room, Jayhawk Hotel, Topeka, Kansas. Thomas W. Williamson Company, Architects. A lighting arrangement suitable for many types of gatherings.

Corridors, for example, are usually poorly lighted, making it difficult to find room numbers, due to the improper spacing of the lighting units. When lamps are placed on comparatively close centers the wattage may be low and insufficient. A bright intensity is not necessary or desirable, yet visibility should be good and glare eliminated, especially if an emergency necessitates the reaching of exits or fire escapes. Ceiling lights in corridors should be so placed that their rays will not annoy guests by shining through transoms. They may easily be shaded to project their rays predominantly downward. A device known as "Glo-Ray," described on page 196, is very serviceable in the illumination of hotel corridors.

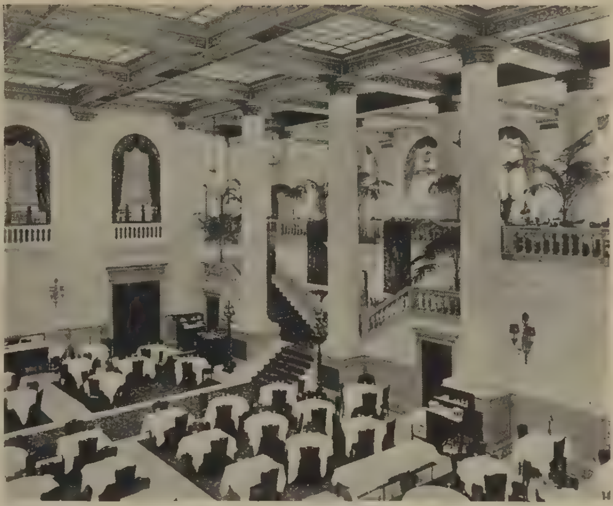


FIGURE 313—Dining room, Gibson Hotel, Cincinnati, Ohio. Gustave W. Drach and Associates, Architects. Color lighting from reflectors above skylight.

The guest room, of all places in these commercial institutions, should be provided with a "homey" atmosphere, with a touch of color in the artificial lighting, practical arrangements for seeing at the dresser, and with a comfortable reading light from an indirect portable lamp.

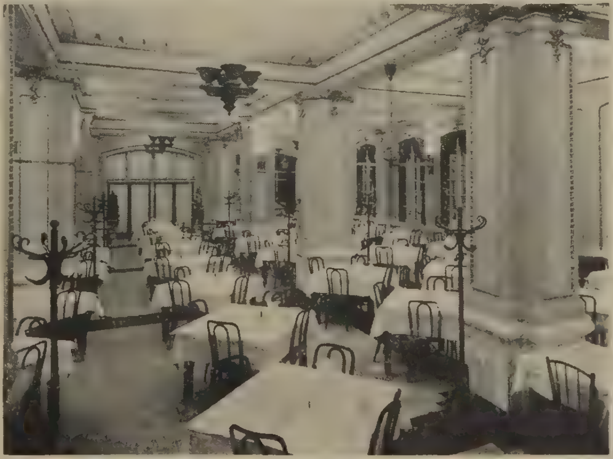


FIGURE 314—Main dining room of hotel, showing use of specially designed luminaire for indirect lighting.

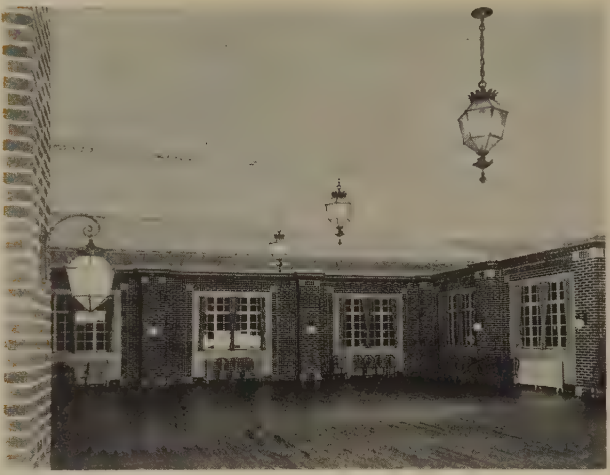


FIGURE 315—Roof garden, Hotel Jayhawk, Topeka, Kansas Thomas W. Williamson Company, Architects. Effective lighting from ceiling and bracket lanterns.

The hotel dining room frequently serves as an assembly room, and is used for banquets, conventions and noonday luncheons. On such occasions it is usually desired to have a flood of light. Many of these rooms are equipped with wall brackets in addition to the fixtures for general illumination, and it is not unusual when a speaker is addressing an assembly, that glaring bracket lights directly behind the platform shine with full flare into the eyes of persons endeavoring to concentrate their attention. To sit an hour through facing these lamps is a very uncomfortable and menacing experience. In the planning of banquet rooms this very important condition should be kept in mind, and if bracket lights are desired to avoid monotony, they should be well shaded and used principally for the touch of color that they might add to the artistic scheme.

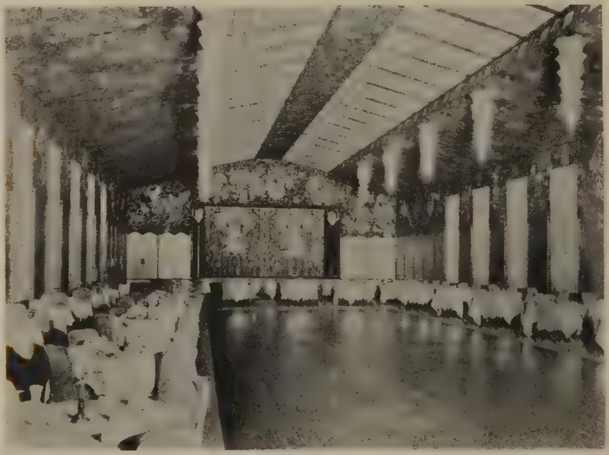


FIGURE 316—Roof garden, Gibson Hotel, Cincinnati, Ohio. Gustave W. Drach and Associates, Architects. Unusual lighting in an unusual interior, creating a distinctly "moderne" atmosphere.

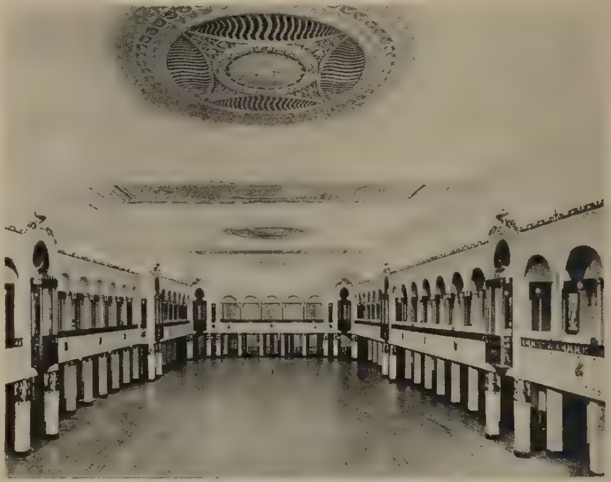


FIGURE 317—Large ballroom in city hotel, showing effective use of cove lighting and the spacious effect that results from absence of ceiling fixtures.

The Florentine dining room of the Hotel Gibson, in Cincinnati, is particularly interesting from the lighting standpoint, inasmuch as illumination is by means of X-Ray reflectors above the ceiling panels. This is in reality a false skylight, since the artificial illumination is exclusively used in the room, no natural light whatever being provided. The several hundred reflectors required for the installation are wired for four

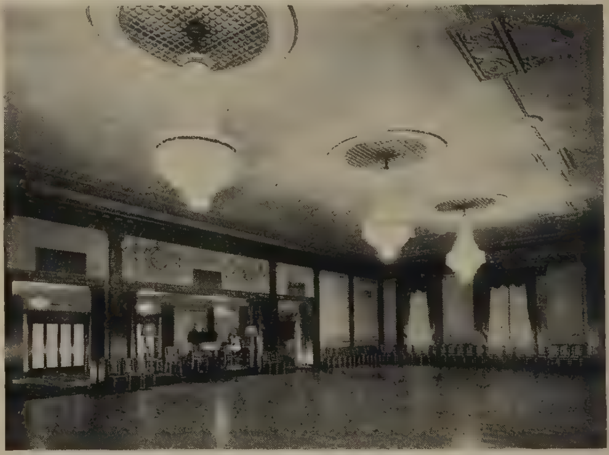


FIGURE 318—Ballroom of the Niagara Hotel, Niagara Falls, New York. Good lighting may be combined with artistic value in the crystal luminaire.

colors—red, white, blue and amber—making it possible to obtain numerous interesting color effects by proper switching and an automatic dimmer control. With the amber lighting a cheery and warm artificial sunlight illumines every corner, while the blue light gives a very effective moonlight atmosphere.

On the upper floor of the Hotel Gibson is the roof garden, designed by Joseph Urban. The treatment, rather extraordinary in its detail, is emphasized and beautified by spectacular lighting effects so essential to a night club. The interior of the room is hung with colored fabrics in fantastic design, and the lighting effects with a variety of color changes are produced through glass panels along the sides of the room and above the dance floor.

The light that filters through the imitation windows is reflected from a background that receives its lighting direct from silvered reflectors and lamps, placed vertically along the two sides of the window, as shown in Fig. 319. By this indirect means a very pleasing and faithful reproduction of daylight streaming through the windows is secured. A similar scheme for the glass ceiling panels also utilizes the indirect lighting method. Special concentrated lighting for the dance floor, for the stage, and the orchestra are essential elements of the illumination scheme. It is in rooms of this character that control by Lumitone, described on page 56, is particularly ideal.

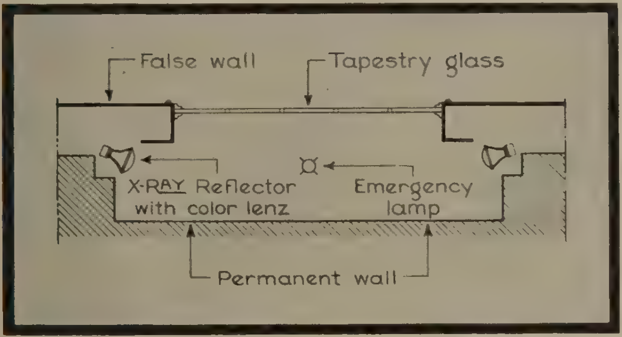


FIGURE 319—Diagram showing general method of lighting for roof garden of the Gibson Hotel. See Figure 316.

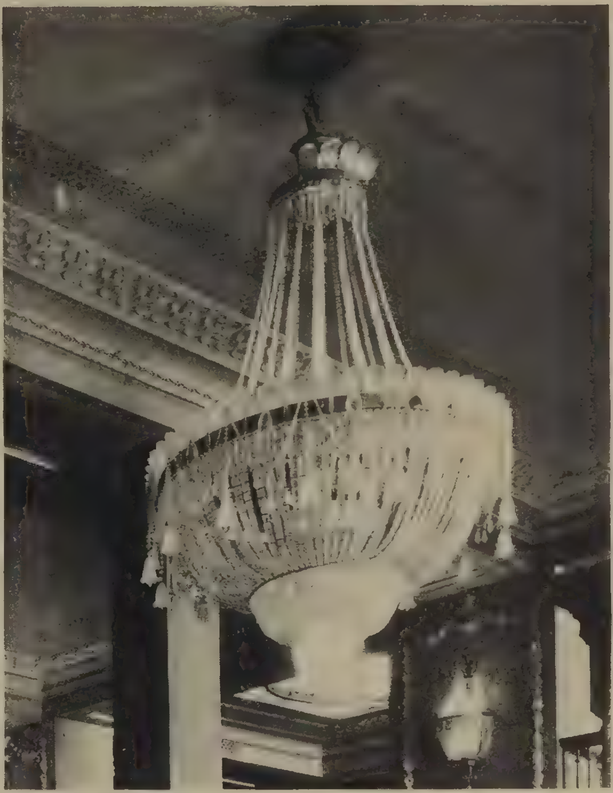


FIGURE 320—Type of crystal chandelier suitable for installation in hotel ballrooms.

The artistic possibilities of concealed lighting are very great and have been utilized in many installations for ballrooms, dining rooms and lobbies, giving a superior quality of illumination. This method was made use of in the ballroom illustrated in Fig. 317, where the room is flooded with a uniform illumination from reflectors and lamps that are entirely concealed from view. This ballroom is a huge interior, 78 feet in width, 180 feet long, and circled by a gallery divided into fifty-six boxes, with the customary promenade behind them. The decorative scheme and furnishings of the room are Italian, carried out in delicate shades of orchid, purple, white and gold. To flood the interior with diffused illumination and retain the spacious appearance, the cove or cornice method was adopted, with reflectors running along the two sides of the room, and wired on two circuits for flexible control.

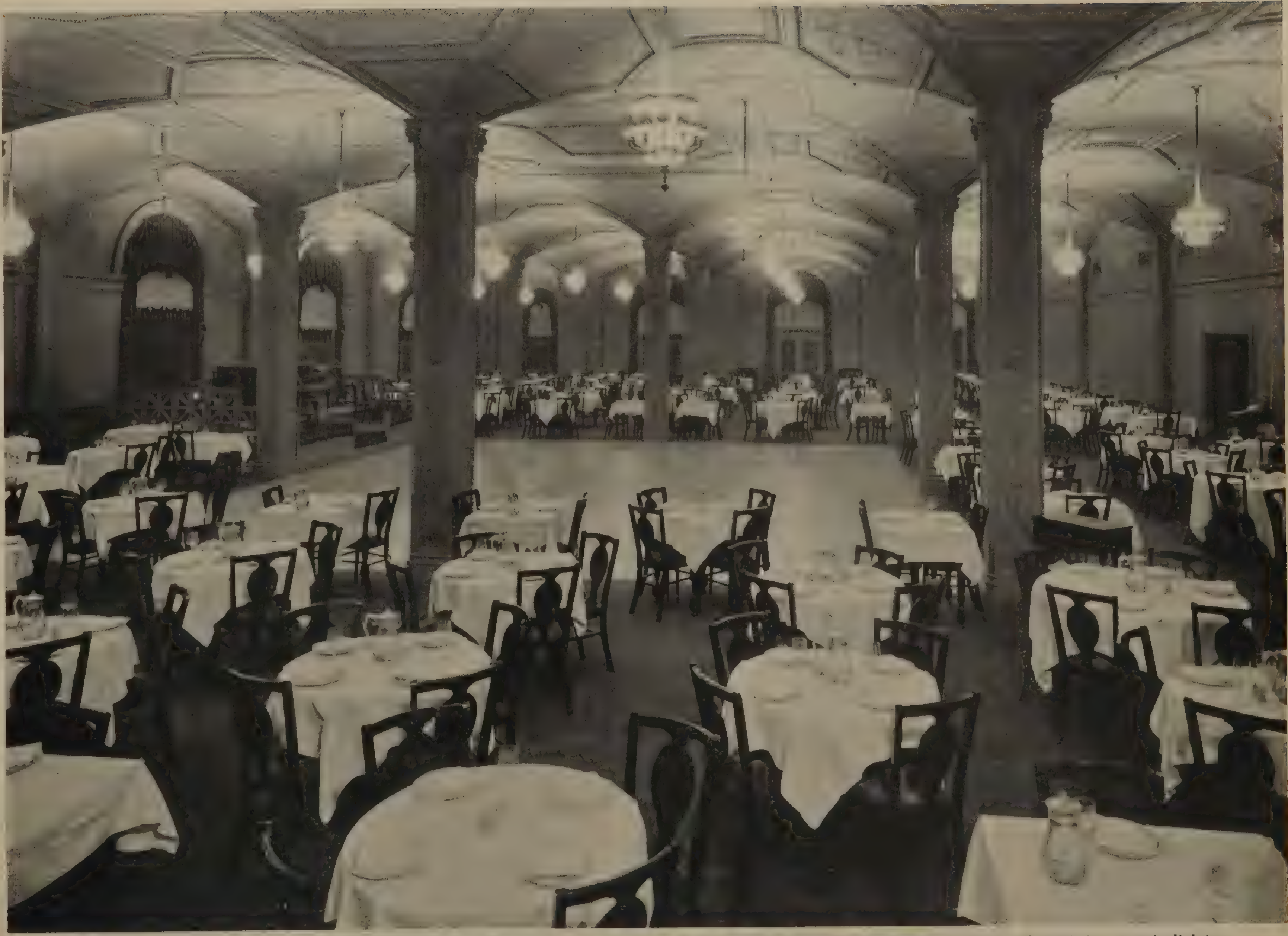


FIGURE 321—Main dining room of Brandeis Restaurant, Omaha, Nebraska. George D. Prince, Architect. The luminaires emphasize the artistic aspect in lighting.

RESTAURANTS

ACCORDING to tradition, the Spartans instituted public meals in order to correct extravagance. All citizens were required to eat at a common table; not even the kings were excluded. It is stated that the refectories consisted of special halls, in which were tables of rough boards placed on trestles, and the seats were plain wooden benches. For many years the Greeks sat at tables to eat, but after their European conquests they became more luxurious and adopted the Persian custom of reclining on couches.

It seems that neither in Athens nor in Rome much attention was given to decoration, ventilation or illumination of refectories, except some of the great halls. One writer states that the ample dining rooms of the renowned Lucullus were richly decorated, airy and brilliantly lighted.

In England the inns began with the Roman conquest, while in America the institution of taverns followed immediately upon the settlement made by the Pilgrims.

The advent of the railroads and great increase in travel, as well as growth of cities, created a decided change in the taverns. They soon came to be called hotels. The same influence is responsible for the development of the restaurant.

One of the errors that is often made in the planning of lighting for this class of interior is to assume that the fundamental conditions are the same as those for a store or office. For this reason we often find them illumined with the same types of units, installed in the same manner as in mercantile establishments. For the cheap lunch room and restaurant this may be satisfactory, but for the high class places a different treatment is essential. Visibility is not the chief consideration.

There are a few important considerations which may be difficult to apply in large establishments, but which by careful planning can be obtained in many cafes, restaurants and tea rooms to give a sense of privacy and intimacy. These conditions provide for the concentration of light

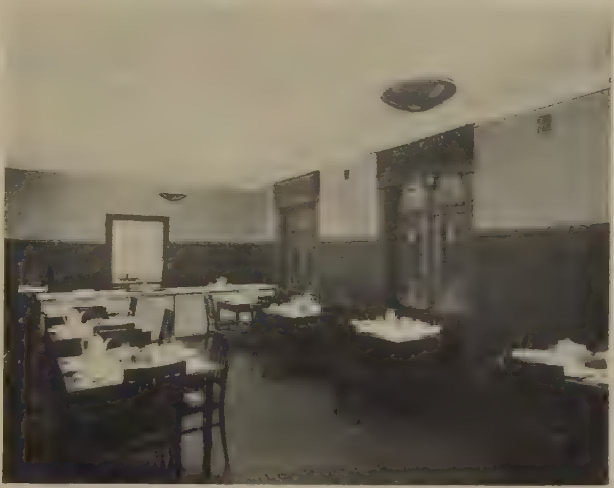


FIGURE 322—Margarin A/B Zenith lunch room, Malmo, Sweden.

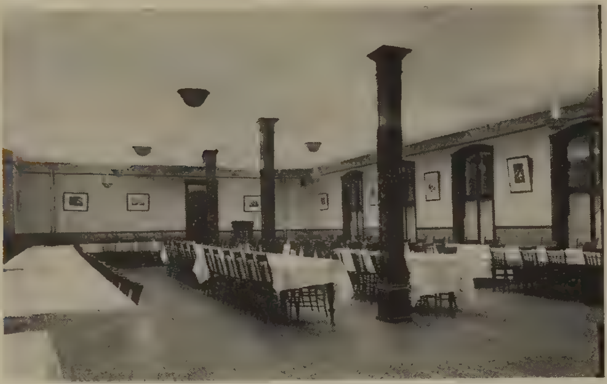


FIGURE 323—Dining room in Church of Immaculate Conception, Montreal, Canada. Jules Lanthier, Engineer.

upon the table to accentuate the linen, silverware and glassware; second, for the proper shading of the light from the eyes of the diner; third, suitable intensity for seeing about the room; and fourth, the supplying of a tinted light to fall upon the faces of those seated at the table.

There is a tendency in the commercial restaurant to over-lighting. The public eating place reflects the atmosphere of the society that it entertains, and this should be kept in mind when planning the lighting. Above all things, strong contrasts in brightness should be avoided. Visible bright light sources are accentuated by mirrors, walls and columns. In many cases the design of the luminaire is too elaborate. It does not convey the general idea of comfort, quiet and simplicity which are essential if the homelike appearance of the interior is to be maintained.

The examples of modern lighting of public eating places that are described in these pages have been selected to illustrate various methods of lighting applications. The room shown in Fig. 323, for example, is typical of the dining rooms to be found in many public institutions. Good lighting is essential in order that the service may be speedy and orderly. It is evident from the illustration that artistic considerations are not to be encountered to a very great extent in this kind of interior, the chief problem being that of supplying well diffused illumination. A metal style of indirect fixture with 300-watt lamp provides a suitable intensity of artificial lighting.

In Fig. 325 is shown a typical commercial lunch room. It will be noted that the luminous type of fixture is employed, and that the arrangement is such as to give a general lighting effect. Slightly more consideration is given here to the artistic character of the lighting unit. The low ceilinged room makes it necessary to suspend the luminous fixtures on short chains.

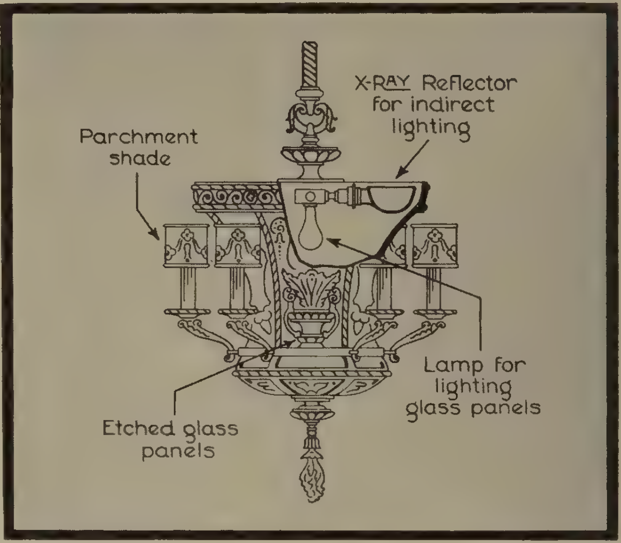

X-RAY Reflector for indirect lighting
Parchment shade
Lamp for lighting glass panels
Etched glass panels

FIGURE 324—Type of luminaire installed in Brandeis Restaurant, Omaha, Nebraska.

Still more emphasis is given to the artistic consideration in the lighting of the main dining room of the Brandeis store in Omaha, pictured on page 180. The architect in this case has selected an indirect luminous type of fixture, the glass panels of which are etched in colors to harmonize with the polychrome finish of the fixture and the

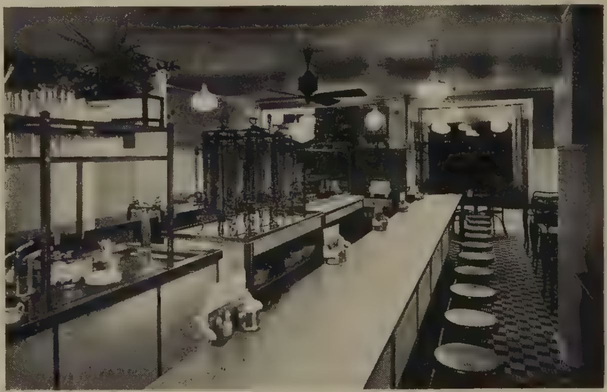


FIGURE 325—Proper scheme of lighting for typical restaurant.

decorations. Twelve small parchment shades are mounted on candles surrounding the body of the luminaire, as illustrated in Fig. 324. The supporting stem is covered with cord of an orange shade.

In restaurants of the better class the lighting is not always confined to the use of suspended fixtures. It is frequently more desirable to resort to a scheme of cove or concealed lighting, examples of which are illustrated in Figs. 327 and 328. It is evident that for the dining room which has a ceiling less than ten feet in height suspended fixtures would be very obtrusive. The logical solution, therefore, of the lighting problem is to favor a method that utilizes the tops of the columns for the concealment of reflectors and lamps. For the Temple dining room the reflectors employed are of a 200-watt size, such as illustrated more in detail on page 105, in Fig. 148.

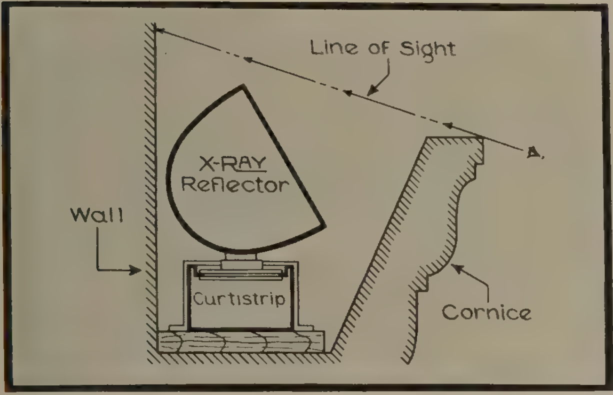


FIGURE 326—Cove lighting method similar to that employed for the Miller Restaurant, Baltimore, Md.

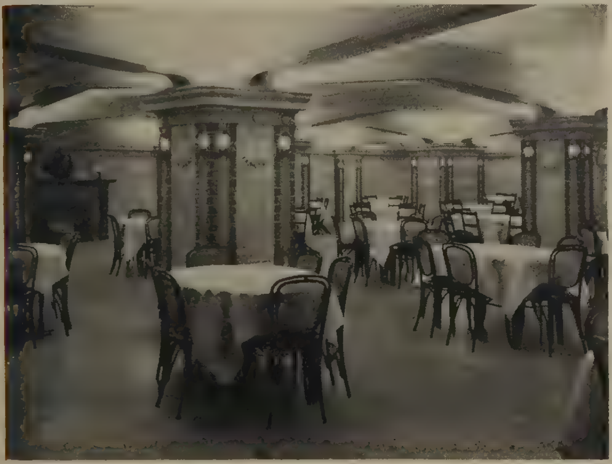


FIGURE 327—Masonic Temple Dining Room, Erie, Pa. Shutts & Morrison, Architects. Lighting suitable for low ceilinged interiors which often present difficult problems.

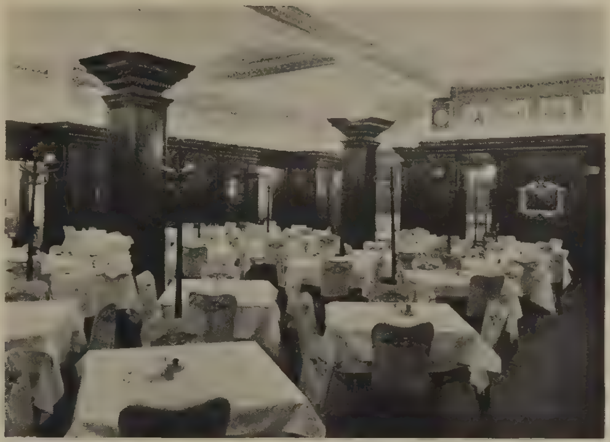


FIGURE 328—State Room of Miller Restaurant, Baltimore, Md. Newton E. Spiess, Contractor.

The architectural treatment of the Miller Restaurant is such as to lend itself particularly to concealed lighting, since a natural receptacle for reflector units is provided at the base of the frieze work above the side wall panels. The ceiling receives the flux from the large number of small units, and produces a general lighting effect, which is desirable in many installations of this kind. Unquestionably the room would be marred by suspended fixtures of any sort. The proper view would not be obtained of the interesting decorative treatment along the walls, where are depicted the coats of arms of the various states of the Union. The method of lighting also brings these paintings into bold relief.

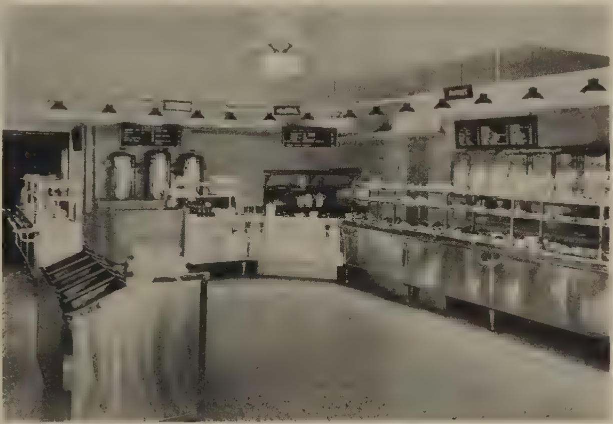


FIGURE 329—Cafeteria with typical lighting arrangement for food racks.

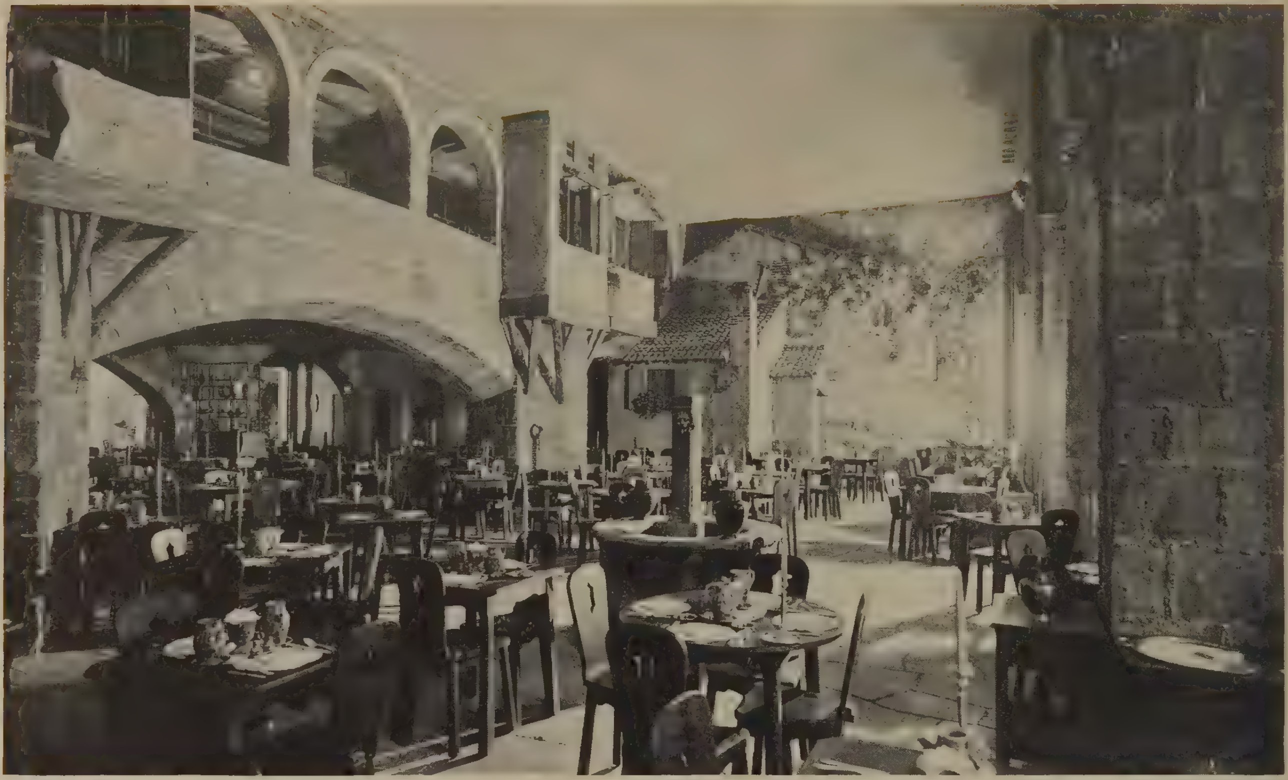


FIGURE 330—Coffee Shop of Alice Foote MacDougall, New York City. Such quaint and pleasing interiors call for special lighting treatment.

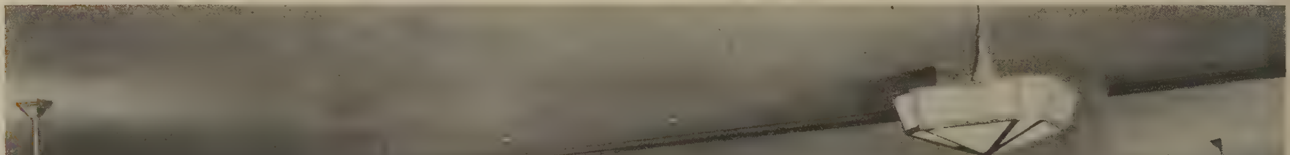


FIGURE 331—Trust Officers' Dining room, Union Trust Company, Detroit, Michigan. Smith, Hinchman & Grylls, Architects. Luminaire of modern art design.

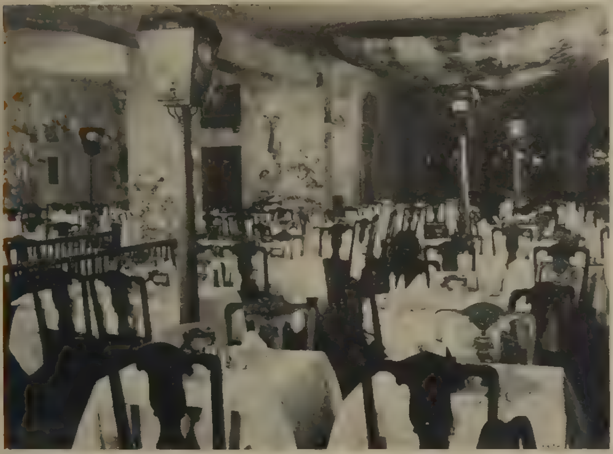


FIGURE 332—Cairo Restaurant, Boston, Mass. John M. Gray Co., Architect.

The development of the cafeteria in our large cities has been very rapid. We now find establishments seating several hundreds of people. One requirement cannot cover the lighting of the entire establishment. The dining area calls for the general illumination, while the space devoted to steam tables requires a localized lighting treatment. A typical example of this is shown in Fig. 329, where the steam tables and food racks are given a special concentrated lighting from reflectors installed at the ceiling. It has been found that generous lighting assists the patron in more quickly making a selection of the various foods.

As coming under the class of restaurants requiring special treatment, a novel and striking scheme is employed in the 46th Street coffee shop of Alice Foote MacDougall, in New York City. This restaurant, known as the Firenze, is one of a series of unique coffee houses which have the colorful atmosphere of Southern Italy.

Introduced into the decorative scheme are novel lighting units which produce just the proper atmosphere. No general illumination scheme is provided, but small local lighting units are utilized to produce the total effect, which is somewhat theatrical, and extremely satisfactory.

The modern tendency in design has introduced another problem in the lighting of the public eating places, as will be noted in the illustration Fig. 331. Modern art makes it necessary to conform as strictly as possible in the design of the luminaires to the decorative treatment of the interior. The fixtures in this case are strictly of the indirect type, containing X-ray reflectors, which direct the light to the ceiling, with auxiliary lamps which illuminate the glass panels of the fixture.

To illustrate the unique methods that may be employed in the lighting of public eating places, the examples shown in Figs. 332 and 333 are given. In the Cairo Restaurant an attempt was made to finish the interior like a street, and hence the lighting scheme that was suggested was one that utilized a type of street lamp post giving a faint glow through the glass and casting an upward light to the ceiling, which was covered with batik hangings. Reflector units were concealed behind the hangings, and are used for a secondary effect. At the ends of the room colored glass windows are illuminated by transmitted light.

A variation of "pedestal" lighting is to be found in the Old Town Coffee Shop, which has the ceiling decorated by Tony Sarg with a map of early Chicago. The most satisfactory and logical method of lighting the map is by means of lamps concealed in floor pedestals constructed of knotty pine to conform with the scheme that is used in decorating the room. Each pedestal contains reflectors designed for a broad spread of lighting, as it is necessary to have the ceiling as perfectly uniformly illuminated as possible.

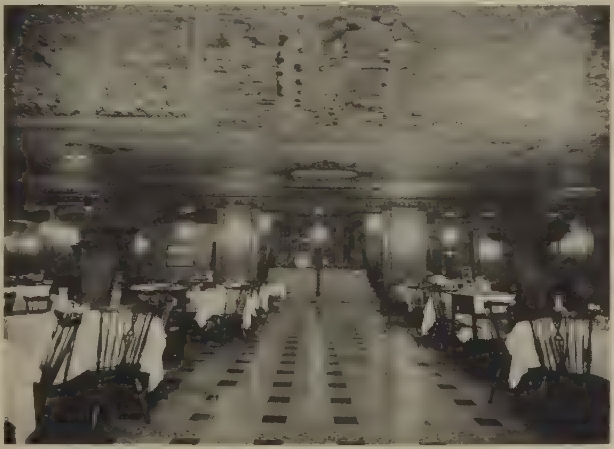


FIGURE 333—Old Town Coffee Shop, Hotel, Sherman, Chicago, Illinois. Holabird & Root, Architects.

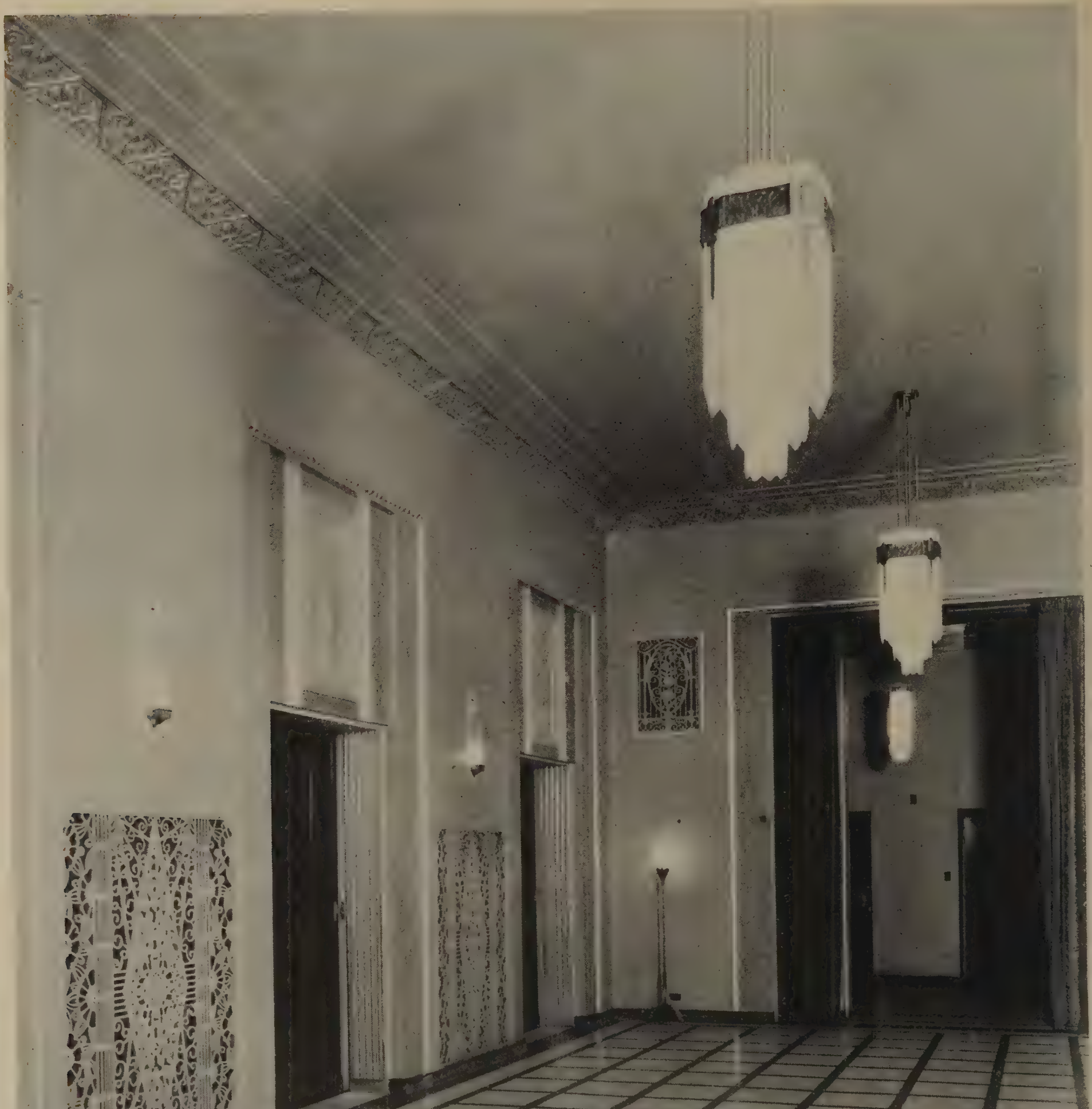
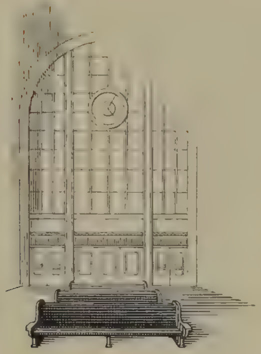


FIGURE 334—The main lobby of the Masonic Temple in Decatur, Illinois. The architects of the building are Holabird and Root, of Chicago. Two pendant luminaires of modern design are the principal elements in the lighting scheme. Brackets and torcheres add decorative touches.



PUBLIC SPACES

MODERN lighting must be completely and effectively harmonized with the architecture and decorations of the public spaces of our beautiful buildings. We must constantly guard ourselves against the usual mistake of trying to "fit in" luminaires which are artistic in themselves but entirely incongruous with their surroundings. Our guiding thought in the making of future installations should be that the illumination must serve and cooperate with the other arts in bringing about complete harmony in the interior. The problem is more than one of providing adequate illumination. It is usually one in which the artistic aspect predominates.

The illumination of the entrance of the public structures is of vital importance, because of the kind of impression it gives to the patrons of the building. In Fig. 334 we see the main lobby of the Decatur Masonic Temple, which has been designed along modern lines, but with proper restraint in the selection of decorative motifs and in the furnishings. The luminaires are of three types, all of which reflect the new trend in design. The ceiling fixtures consist of lantern shaped clusters of glass plates, symmetrically arranged and supported from a metal band of bronze. These units are equipped with low wattage lamps to reduce the brightness. The diffusion is obtained by etching the glass. Harmonious wall brackets

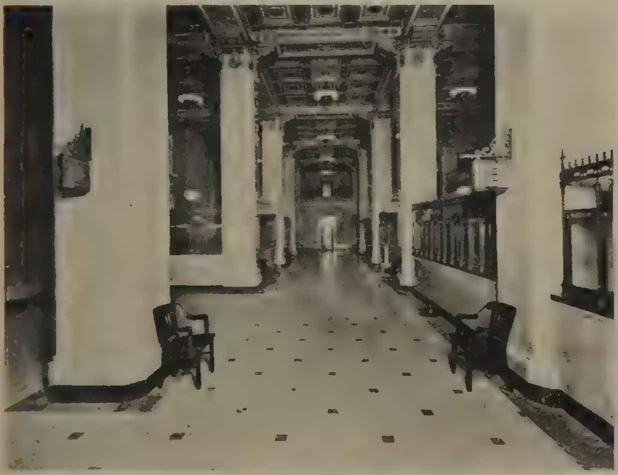


FIGURE 335—The lobby of the Southwestern Bell Telephone Company, Dallas, Texas. Lang and Witchell, Architects.

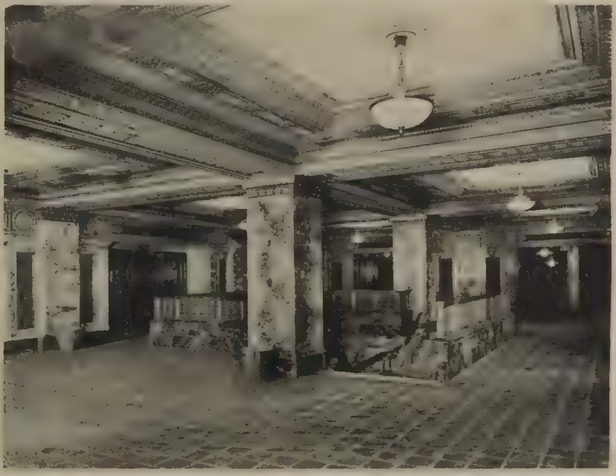


FIGURE 336—A lobby of the public Auditorium, Cleveland, Ohio. A luminous fixture of the indirect type is effective.

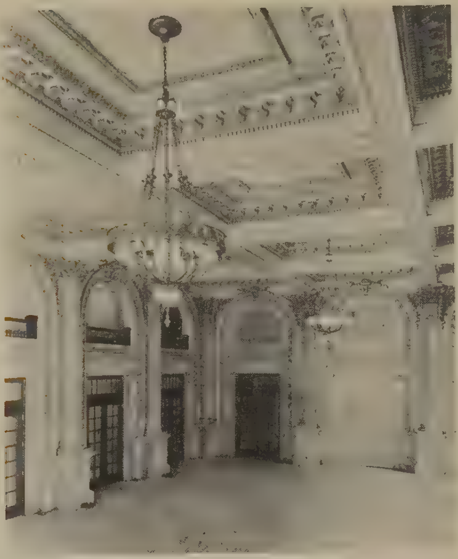


FIGURE 337—Soldiers and Sailors Memorial, Kansas City, Missouri.

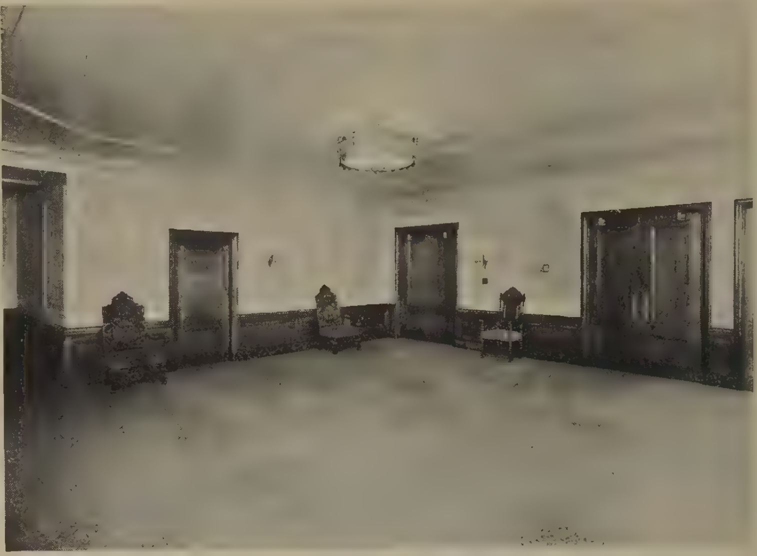


FIGURE 340—Upper lobby, Southwestern Bell Telephone Company, Dallas. Texas. Lang and Witchell, Architects.

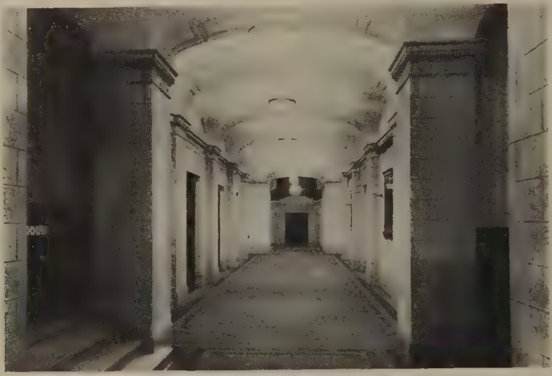


FIGURE 338—Main lobby, Smith Memorial Music Hall, University of Illinois, Urbana. James M. White, Architect.

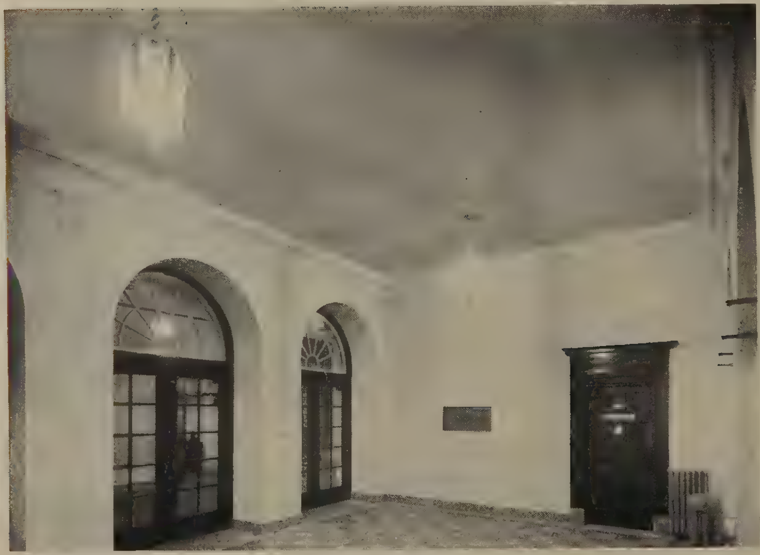


FIGURE 339—The lobby of the Liberty Memorial High School, Lawrence, Kansas. A lantern of brass and glass supplies general illumination.

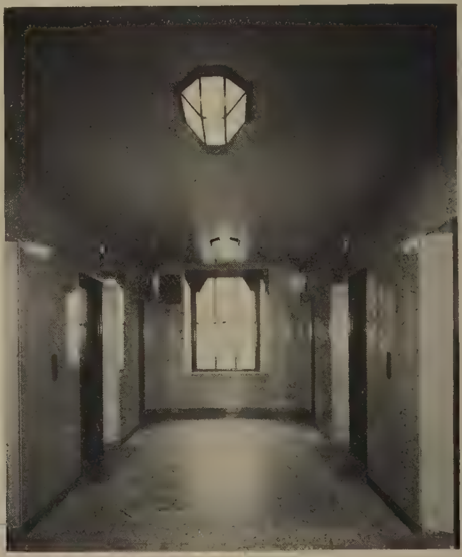


FIGURE 341—Elevator lobby, Union Trust Company, Detroit.

and units of the torchere type complete the lighting arrangements of the room. Altogether, the visitor receives a pleasant and satisfactory reaction as he enters this interior.

The most fascinating feature of the Cunard Building, in New York, is the great hall. The walls, floors and counters are done in Travertine. The ceiling surface is a stupenduous composition of color harmony by Ezra Winter, and at a lower level are interesting maps by Barry Faulkner. Painted in the circular insets are sea creatures of many kinds, expressing the fascination which the sea has always possessed for the imagination of the world. The decorations of the dome are in flat tones, without gloss or disturbing reflections, and depict the strange craft of the early mariners.

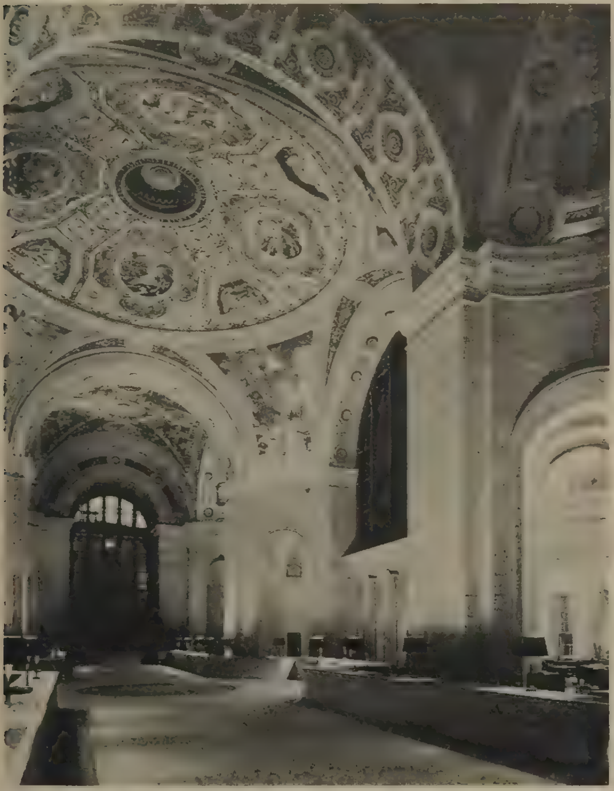


FIGURE 342—The Great Hall, Cunard Building, New York City. Light projected upward from counter lamps floods the beautiful ceiling.

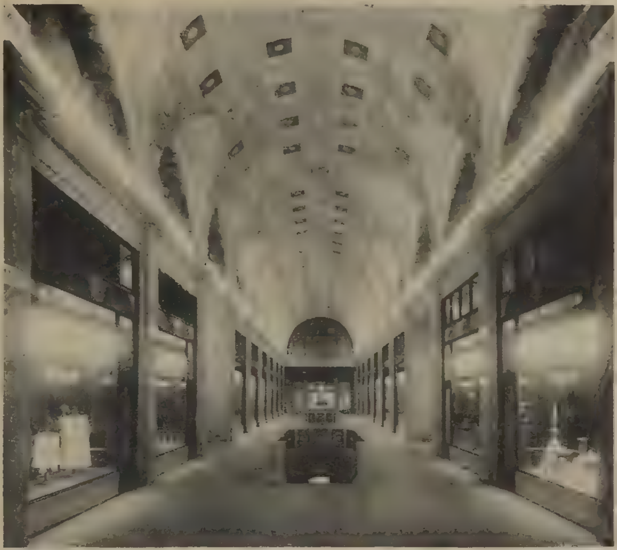


FIGURE 343 -Arcade of the Dixie Terminal, Cincinnati, Ohio. Garber and Woodward, Architects; Fosdick and Hilmer, Engineers.

Upon the counter are special lamps that supply the upward component of the lighting. Each lamp contains an X-Ray silvered reflector of the concentrating type. In addition, four silvered reflectors, tilted at an angle, contribute the lighting for the counter area, upon which maps and deck diagrams are spread out. Sixty cove units, installed in the cornice at the base of the ceiling dome, complete the lighting scheme.

A decidedly interesting case of modern lighting, in which the illumination features have been worked into the general design of the structure, is shown in Fig. 343. The arcade is done in the Italian Renaissance, with medallions in shallow relief featured in the vaulted ceiling. In selecting a system of illumination for this space it was decided that no lighting source or accessory be in view against the decorative ceiling, yet that the details and coloring be pleasingly exhibited by light thrown upward. It was necessary also to

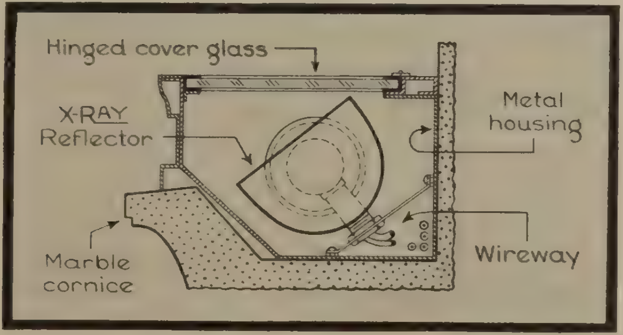


FIGURE 344—Detail of the cornice lighting method for the arcade of the Dixie Terminal Building, Cincinnati, Ohio.

consider that the gallery floor, with its rows of shops, should be protected from all glaring reflections. Cove lighting from the cornice at the front of the baluster rail was the only practical method of accomplishing this result. The arrangement of the lighting trough is shown in Fig. 344. Its various sections are wired to permit of three intensities of illumination. A low lighting value is used after the rush of late evening traffic.

The reception room illustrated in Fig. 345 has a flexible system of illumination as a result of thoughtful planning. The ornamental cornice surrounding the room has been enlarged sufficiently to accommodate reflector units for indirect lighting. A candle type luminaire has been installed in the center of the ceiling. The table and floor portables contribute the supplementary lighting, and thus the room is provided with equipment to produce a homelike atmosphere that soon puts the patrons of the establishment at ease.

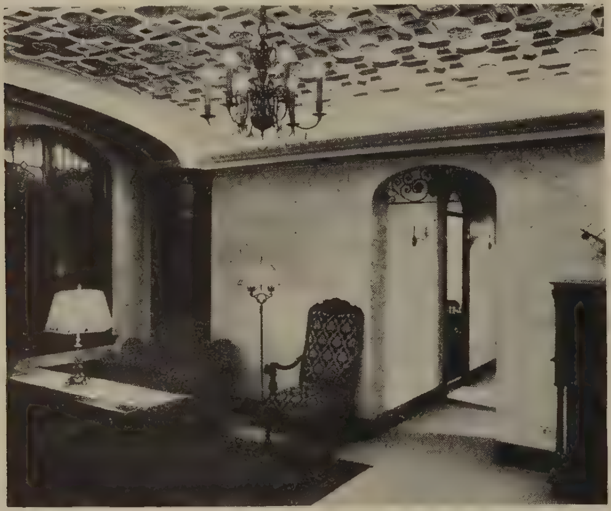


FIGURE 345—Reception room of the S. S. White Dental College, Chicago. Emphasis was made here on the decorative aspect of lighting.

As a departure from the usual method of bracket and ceiling lighting for stair halls, the example in Fig. 347 is offered. A modern design of newel post light is in keeping with the general decorative scheme, and is effective in illuminating the steps and landing, and supplies in addition a unique ornamental feature.

The great central spaces of our railway stations are usually supplied with abundant natural lighting through large windows at the ends or sides of the room, or, as is frequently the case, through a glass ceiling. Equally important is the provision for artificial illumination. Due to the unusual size of these rooms and the height of the ceiling, special lighting schemes must be resorted to. Rarely do we find these public areas illuminated by means of hanging ceiling fixtures. Ordi-

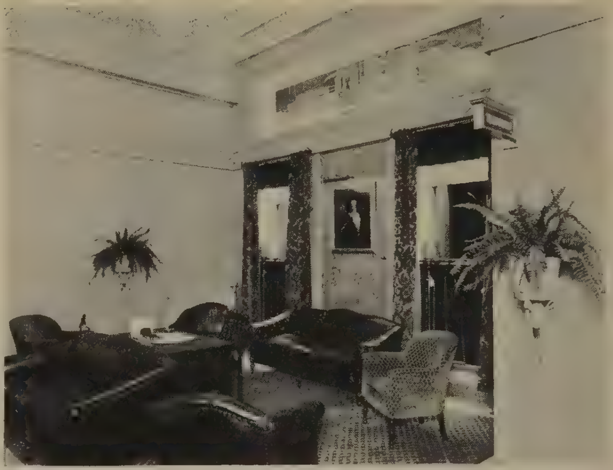


FIGURE 346—Reception room, Public Service Company of Northern Illinois, Joliet. H. V. Von Holst, Architect, Chicago.

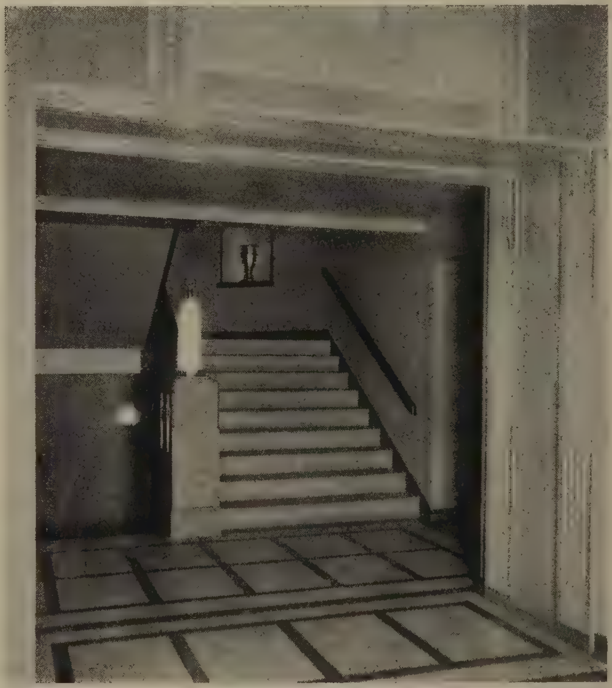


FIGURE 347—Typical stair hall in the Masonic Temple of Decatur, Illinois. Holabird and Root, Architects, Chicago.

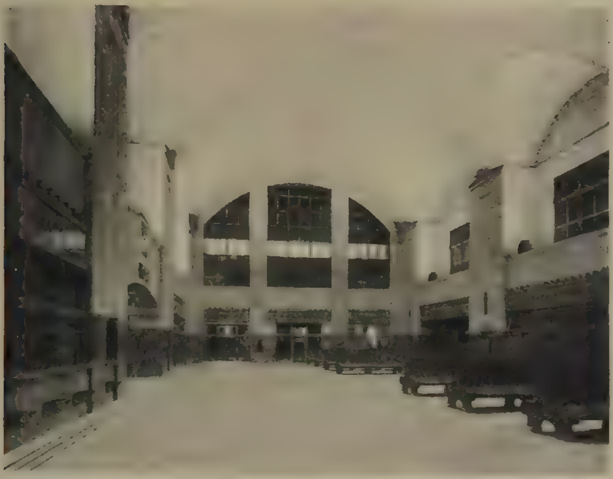
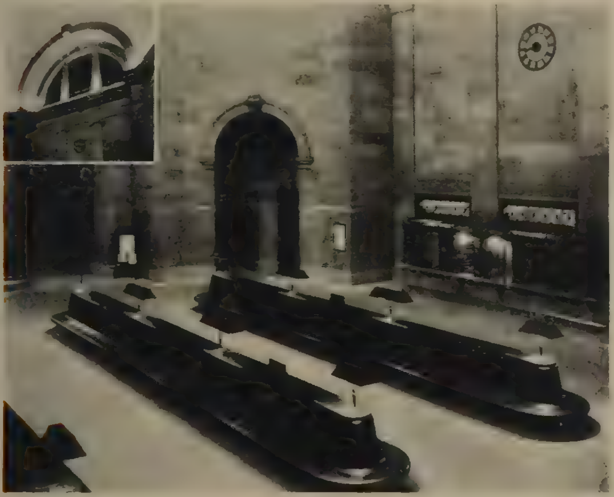


FIGURE 348—Waiting room of the Union Station, South Bend. Indiana. X-Ray reflectors embedded in the ledge at the mezzanine level project light to the ceiling.

narily, a concealed method of lighting is adopted, and one for which the maintenance operation is easily performed.

When the building illustrated in Fig. 350 was designed, provision was made for the concealing of lamps and accessories for the artificial lighting. The large space at the end of the room above the entrance vestibules provides a suitable location for a number of projecting reflectors, designed for a long throw of light to cover the ceiling area with uniform illumination. So carefully are the units concealed that they are not visible from any angle, and so even is the brightness of the walls and ceilings that the source of light is not apparent. The equipment is readily accessible from passageways on the upper floors of the building, so that cleaning of equipment and renewal of lamps become a very simple procedure.



FIGUE 349—Broad Street Station, Richmond, Virginia. Frank C. Eteson, Engineer. The inset shows how by cornice lighting the room is flooded with restful indirect illumination.

For the lighting of the main room of the South Bend station conditions are somewhat more favorable, because of the fact that the ceiling has no skylight. It is covered with acoustical tile which, due of its light color, forms a very suitable surface for the reflection of light. At either side of the room at the mezzanine level and in the ledge of a private passageway reflector units of a special type have been embedded and the individual units covered with glass. The light reflected from this location is directed to the ceiling, which in turn illuminates the entire waiting room space. The reflector used in this instance is so designed that the maximum of the light beam is thrown away from the wall, thus preventing the objectionable wall splashes that are frequently present in installations of a similar character. The waiting room of the Richmond station is octagonal in its plan. Here also concealed lighting method has been resorted to.

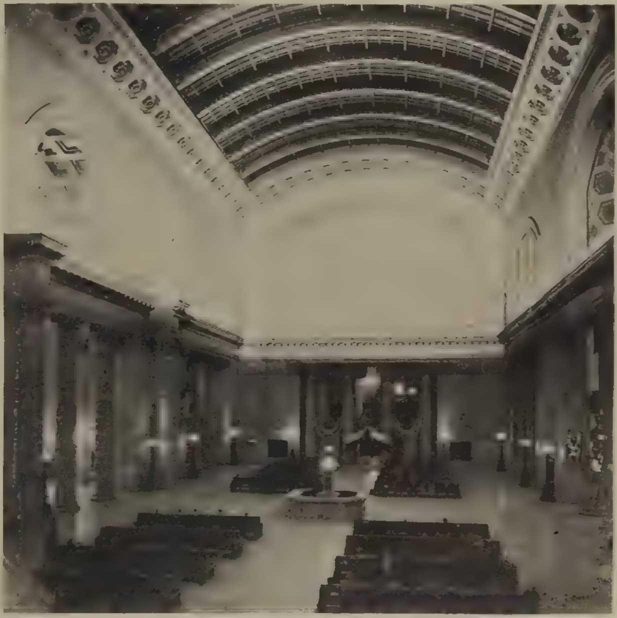


FIGURE 350—Main waiting room, Union Station, Chicago. Graham, Anderson, Probst and White, Architects. At the ends of the room space is provided for powerful reflectors.

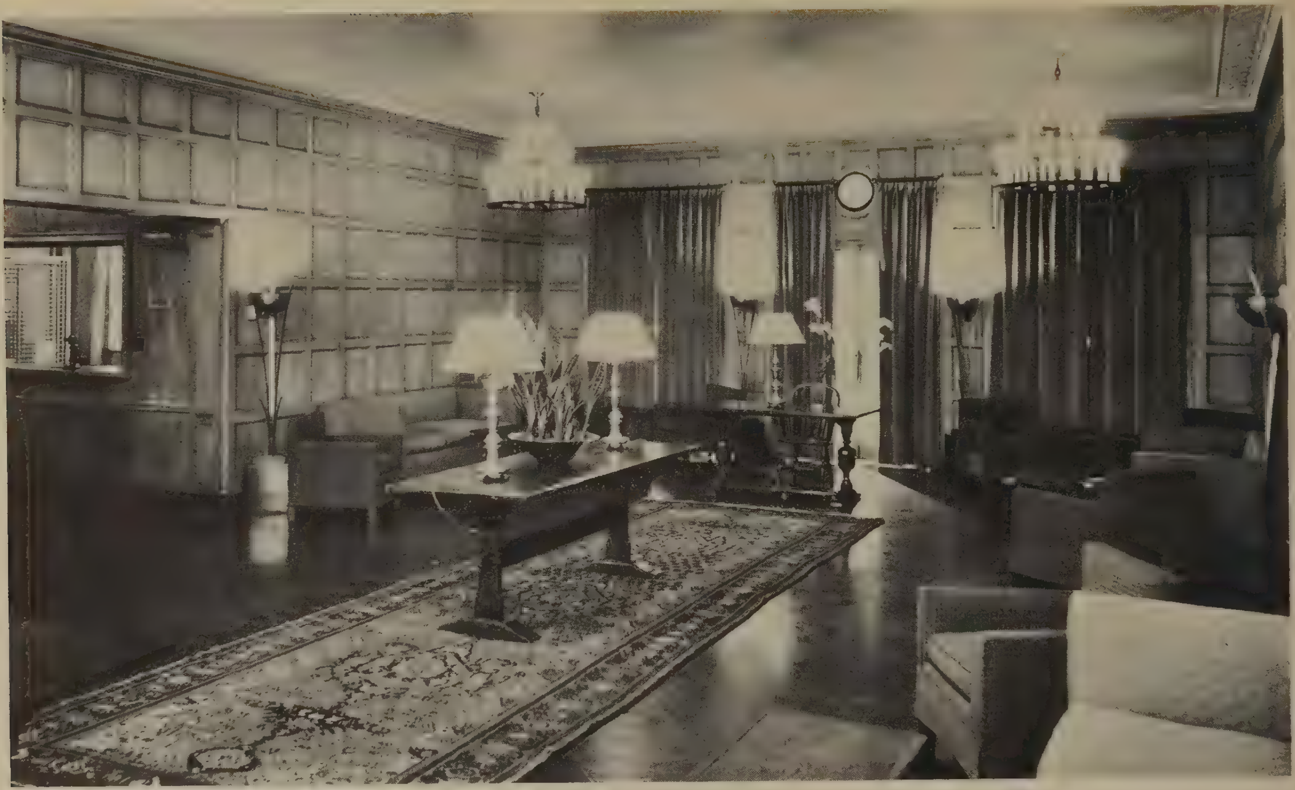


FIGURE 351—The reception room of the Passavant Hospital, Northwestern University, Chicago, Ill. Holabird & Root, Architects. Note the homelike atmosphere in the furnishings and the lighting arrangements.

FIGURE 352—The lobby of the office at Mayo Brothers' Hospital, Rochester, Minn. All the office spaces of this famous institution are equipped with indirect illumination to obtain, as nearly as possible, a lighting of daylight quality.

HOSPITALS

ANYTHING that is conducive to the physical comfort and mental serenity of the patient in a hospital should be considered as a logical part of the equipment of the institution. Sanitation is of the most vital importance. The patient must be safeguarded. Ventilation is also very necessary, as it is conducive to good health. But adequate, non-irritating illumination, properly controlled, is equal in importance to proper diet and efficient medical attention. The lighting should be of a character that does not tend to cause discomfort or fatigue the eyes of the patient. Eyestrain and restlessness, as the results of poor lighting, have a very direct reaction on the nervous system, and may be a contributing cause of delay in the rate of convalescence.

The lobby and reception room of a hospital should be an inviting place. Here the visitor or patient receives his first impression of the institution. If the general aspect, including the illumination, is comfortable and pleasing, tense nerves are relieved and there is at once a feeling of relaxation. Many hospitals have reception rooms generously supplied with easy chairs, tables and other comforts to be found in our homes, and with lighting that is harmonious. Frequently floor lamps and table lamps are employed for their decorative touch. Where conditions are suitable, the indirect lamp described on page 201 is used

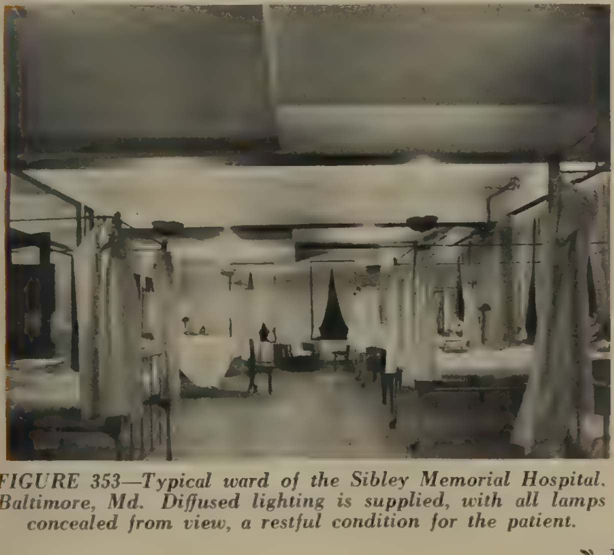


FIGURE 353—Typical ward of the Sibley Memorial Hospital, Baltimore, Md. Diffused lighting is supplied, with all lamps concealed from view, a restful condition for the patient.

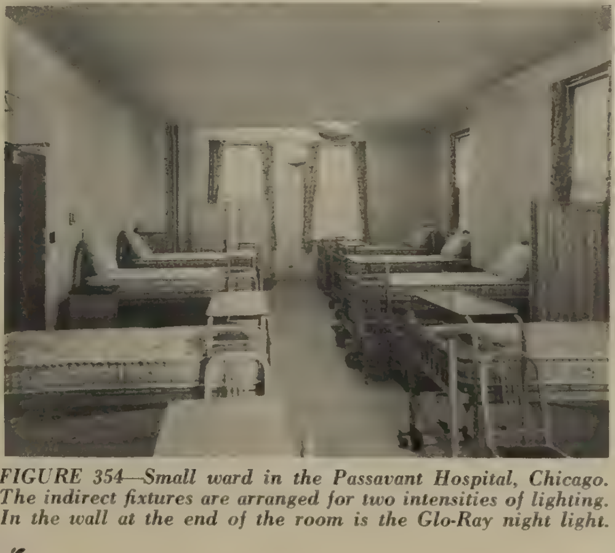


FIGURE 354—Small ward in the Passavant Hospital, Chicago. The indirect fixtures are arranged for two intensities of lighting. In the wall at the end of the room is the Glo-Ray night light.

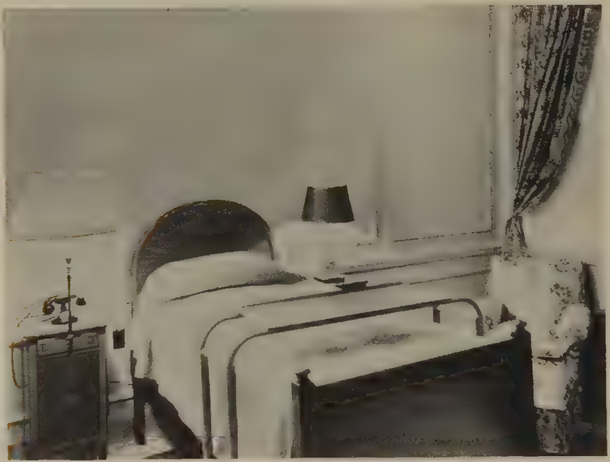


FIGURE 355—Private room, Passavant Hospital, Chicago, showing the use of the indirect portable lamp for flexibility in supplying general illumination as well as local lighting.

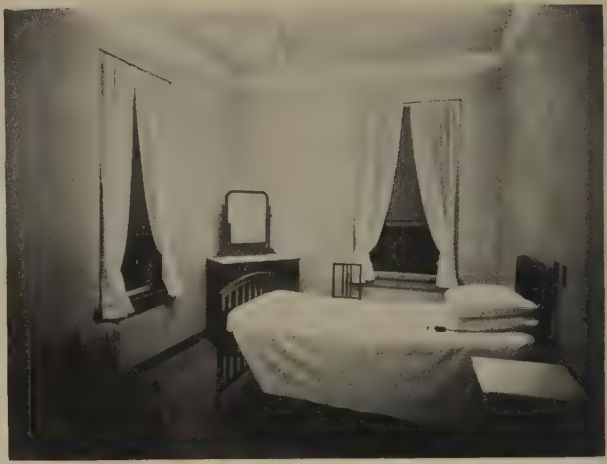


FIGURE 358—A private room, Lakeside Hospital, Kansas City, Mo. Moderate intensities of diffused lighting are secured economically wtih fixtures equipped with X-Ray reflectors.

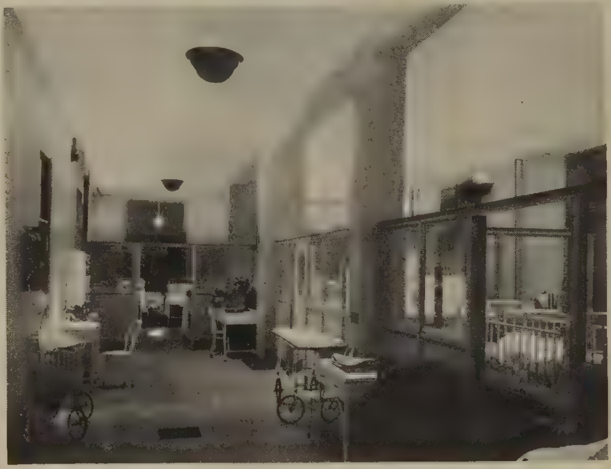


FIGURE 356—General ward in the James Whitcomb Riley Hospital, Indianapolis, Ind. Robert Frost Daggett, Architect. General lighting from indirect luminaires. Night lighting from special luminous panels in the floor.

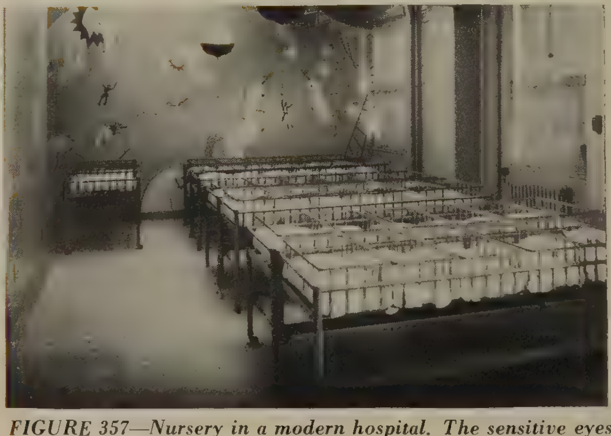


FIGURE 357—Nursery in a modern hospital. The sensitive eyes of infants must be safeguarded. Uncontrolled light may cause permanent defects of vision.

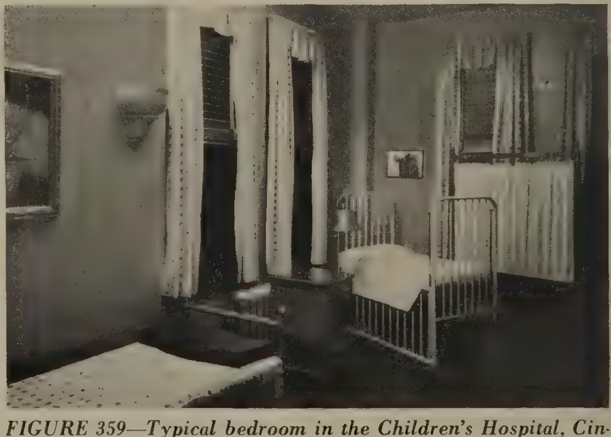


FIGURE 359—Typical bedroom in the Children's Hospital, Cincinnati, Ohio. The principal lighting is indirect from a metal wall urn containing a special X-Ray reflector.

with great success. Just as in our living rooms at home, a comfortable level of lighting, and not a high intensity, is necessary in reception rooms.

Wards and Private Rooms

In the wards and private rooms illumination is one of the most vital factors in the treatment and convalescence of the patient, who is extremely sensitive to diffuseness in lighting. Harsh light irritates the eyes, is very discomforting, and results in undesirable conditions, which retard the progress of the patient very materially.

The logical light for a hospital is the light under which the patient does not become weary; a light that is not too bright to those wishing to rest, nor so dim as to prevent the supervisor from noting the individual conditions of the patient.

When we attempt to illuminate any interior, the best that we can do is to approximate, as nearly as possible, the qualities of daylight. In so doing we strive to secure a light that is as diffused as nature intended light to be. The glaring radiance created by incandescent lamps must be modified and transformed into a warm, luminous glow that pervades every corner of the room with equal strength and equal softness. Since the patient's eyes are directed towards the ceiling the majority of the time, the lighting must be of a nature to relieve strain to the greatest extent.

It is extremely desirable, in the lighting of wards and rooms, that the luminaires employed be planned so that several intensities of light may be secured from the same fixture. For example, one switch may control lamps of small wattage to provide for lighting of dim intensity. Another switch may control more lamps which will give lighting sufficient for general use and reading.

The present tendency in the lighting of private rooms and wards is to consider their homelike appearance, and plan an arrangement which is conducive to general pleasantness. A lighting which will add to the attractiveness as well as meet the utilitarian requirements will have a very beneficial influence upon the patient. Bright lighting is not desired, and the intensities usually employed and recommended are on page 279.

A suggestion is given in Fig. 355 of the important changes that are being made in the manner of equipping the room occupied by the patient. The furnishings are very similar to those of the modern hotel guest room, with indirect portable lamp, telephone service, night table with its small, shaded lamp—everything provided that will contribute to the patient's comfort and recovery.

The most careful consideration should be given to the lighting of rooms in children's hospitals, since young eyes are very sensitive and much too delicate to be subjected to the glare of exposed lamps. The illumination in the nursery should be of a low value and as perfectly diffused as possible from indirect lighting equipment.

The Glo-Ray

Some kind of night lighting device is very desirable, and often necessary in the wards and rooms, so that visits may be made by the nurses and doctors without arousing the patient, or without the necessity of turning on the general illumination. To serve this purpose the small unit shown in Fig. 361, and know as the "Glo-Ray," has been designed to be mounted in the wall just above the baseboard. The light from the unit is-

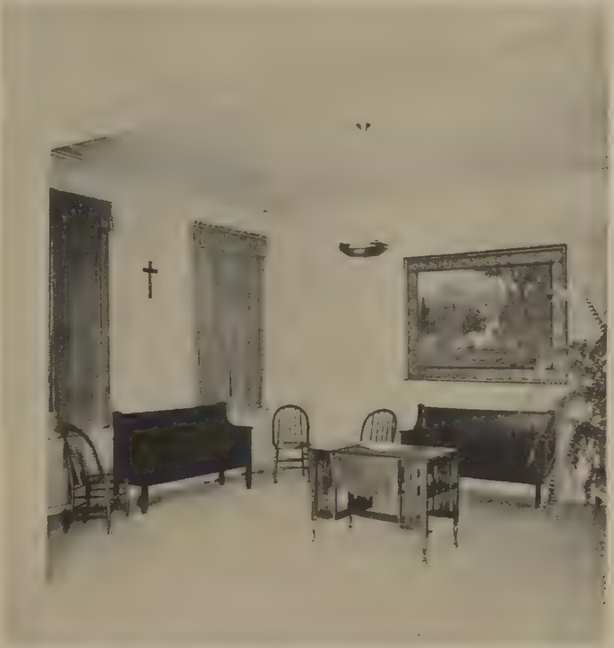


FIGURE 360—The reception room of the Ottawa General Hospital, Ottawa, Canada. Noffke, Morin & Sylvestor, Architects.

sues from a tiny glass window, a small and efficient X-Ray reflector directs the light at a desired angle, and it is so controlled that no rays are projected above the horizontal. Practically all of the radiance is delivered to the floor. With an adjustable shutter arrangement it is possible to control the amount of light delivered into the room, from a very dim value to the maximum capacity.

The "Glo-Ray" night light, usually placed 12 to 18 inches above the floor, may be installed in a partition only 3 inches in thickness. The front cover fits flush against the wall, offering no obstruction. The unit is dust-proof. The wiring compartment is easy of access.

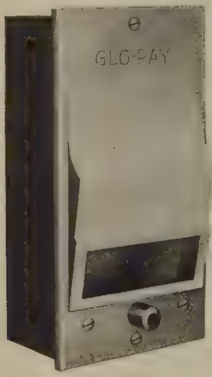


FIGURE 361—The "Glo-Ray," a unit designed to produce a low, softly diffused intensity for night lighting in hospital wards, rooms and corridors. A simple regulating device controls the amount of light emanating from the small glass window.

The lighting of the corridors in a hospital is usually a simple problem, because it is necessary to furnish only the amount of illumination, required for easy passage. The totally indirect method is extremely desirable, because of its comfort to patients who may be transferred from one room to another. The "Glo-Ray" is frequently all that is necessary to install as supplementary to the general system of illumination.

Operating Rooms

The operating room in the hospital has requirements that are radically different from those of any other department of the institution. We find two types of operating rooms, one used for general surgery, and the other, usually found in the educational institution, combining a form of auditorium for the purpose of holding clinics. Although in both cases the illumination on the operating table must be very intense and well diffused, the requirements of the general illumination for the room are somewhat different.

The majority of serious operations are performed by daylight, but many institutions are required to use their operating rooms both night and day. An extremely high intensity of illumination is, therefore, required, so that the minutest details may be easily distinguishable. The character of diffusion of the light is as important a factor as the intensity. Shadows may lead to serious difficulties in certain types of operations. Furthermore, many surgeons insist on having the color of the light approximately that of daylight, stating that the tissues are more nearly exhibited under their true colors. The light must come from many directions, so that the surgeon is never working in his own shadow, and so that any incision is illuminated perfectly. In cases where a horizontal lighting is necessary for penetration, special equipment must be installed.

FIGURE 362—"Glo-Ray" night light. Delivers all of its illumination to the floor. No rays are directed above the top level of the light window. It is most effective when installed from 12 to 18 inches above the floor in a bedroom, corridor or stairway.

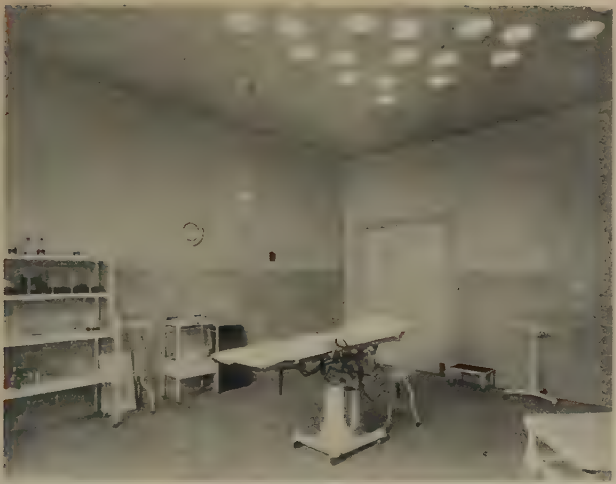


FIGURE 363—Operating room in the Lincoln Methodist Hospital, Lincoln, Neb. Fiske, McGinnis and Schaumberg, Architects. Special X-Ray reflectors are installed above 10 inch diameter diffusing lenses mounted in hinged ceiling rims.

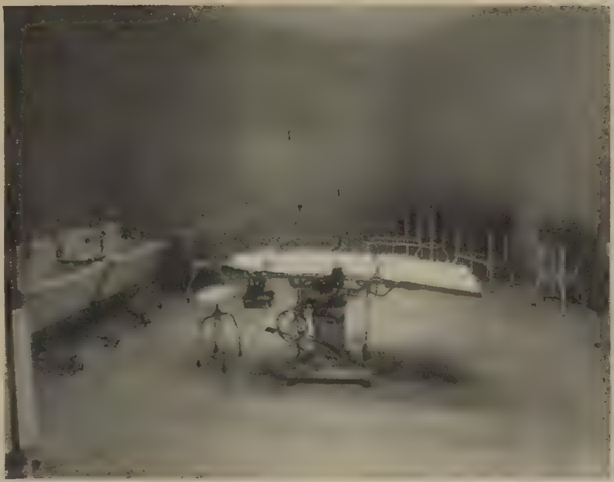


FIGURE 365—An operating room in the clinic of Dr. Pila, Ponce, Porto Rico. F. Porrata Doria, Architect. As shown in Fig. 366, special X-Ray reflectors above the ceiling panels direct their strong beams upon the operating table.

We are accustomed to very high intensities of daylight, and it is found that by increasing the illumination in the operating room the surgeon works with greater facility. No less than 50-foot candles should be supplied for any operating table. A much more adequate intensity on the operating field itself is 1000 foot-candles.

If ever lighting equipment must be efficient and dependable, it is in the operating room. A strong, constant intensity of illumination is absolutely necessary. If for some reason the electrical supply fails, the room will be in darkness unless an emergency system is available. A small storage battery, of sufficient capacity to light the operating room for a given period of time, is most essential. By throwing a switch, such an installation may take care of an emergency. A better arrangement is to have the storage battery circuit thrown in automatically when the regular lighting system is put out of commission.

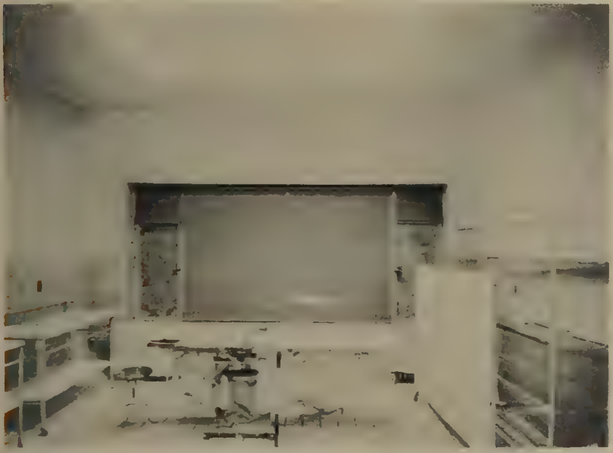
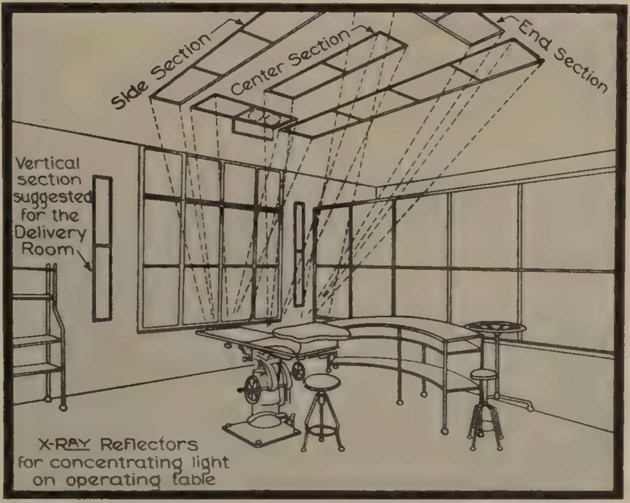


FIGURE 364—An operating room in the Lakeside Hospital, Kansas City, Mo. Archer & Gloyd, Architects. Above the diffusing glass ceiling are 24 X-Ray reflectors of concentrating and distributing types, wired on four circuits.



Side Section
Center Section
End Section
Vertical section suggested for the Delivery Room
X-RAY Reflectors for concentrating light on operating table

FIGURE 366—Detail of method used for concentrated high intensity lighting upon the operating table, as shown in Fig. 365. All equipment is above the ceiling.

Methods of concealed lighting are very advantageous for the operating room. In Fig. 363 is a typical example of the use of individual recessed units. The lighting device consists of a reflector on an adjustable base mounted above the ceiling.

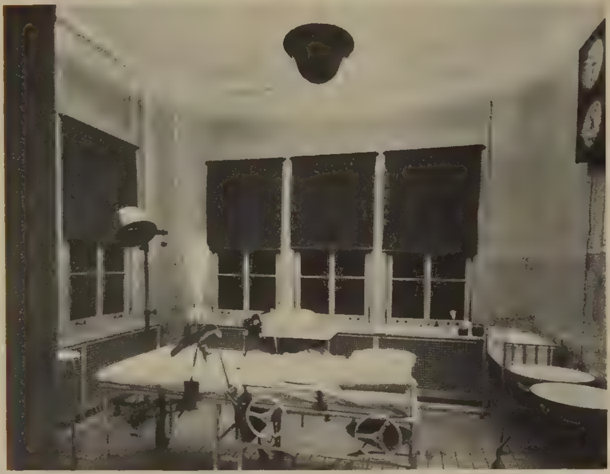


FIGURE 367—Obstetrical operating room in the Good Samaritan Hospital, Cincinnati, Ohio. Gustav W. Droch and Associates were the architects.

The opening in the ceiling is finished with a hinged flange, having either clear or slightly frosted heat-resisting glass. This makes an arrangement that is adaptable to many hospitals.

Where construction permits, and especially in new buildings, reflectors are often recessed in box-like housings, as shown in design of Fig. 366. One of the hinged doors is open to show the arrangement of the reflectors which are all focused upon the operating table. In some buildings a drop ceiling is provided, especially if concrete construction makes recessing reflectors difficult.

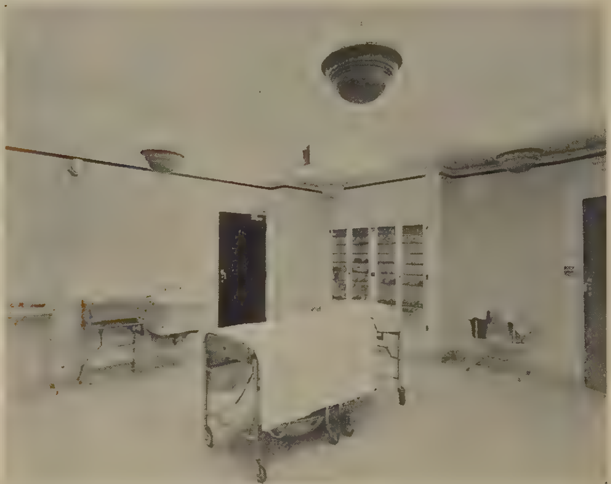


FIGURE 368—Typical operating room in the Ottawa General Hospital, Ottawa, Canada. Noffke, Morin & Sylvestor, Architects. Each indirect luminaire is equipped with a 1000-watt incandescent lamp.

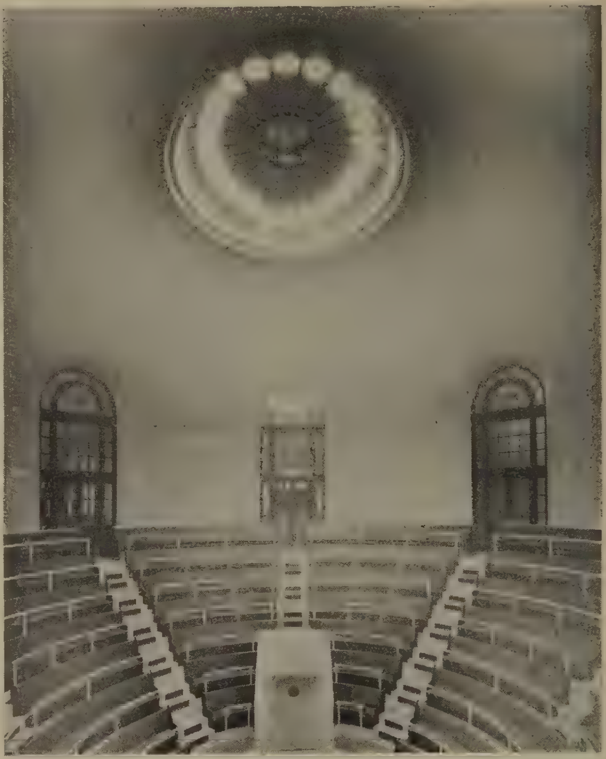


FIGURE 369—Clinic ampitheatre, Jefferson Hospital, Philadelphia, Pa. The high ceiling necessitates the use of concentrated beams of light from X-Ray reflectors above the skylight dome. General diffusion is suffiicent for the ampitheatre.

Because daylight is so variable and does not always have the same diffusion and intensity, many architects and surgeons are now planning operating rooms for artificial lighting only. Indeed, many operating rooms, such as the one completed recently in Porto Rico, and shown in Fig. 365, have no windows. Many surgeons favor this system because of the dependable uniform quality of the lighting. On page 569 of the book entitled "Pediatrics," edited by Isaac A. Abt., M. D., will be found an illustration of what is considered as proper for operating room lighting. The scheme consists of reflectors in steel boxes fitted with diffusing glass, made up in a manner similar to the scheme illustrated in Fig. 366.

Indirect illumination is used with great success in many operating rooms. Where an unusually high concentration of light is desired on the operating field, however, indirect lighting may be used supplementary to a directed system which concentrates strong beams upon the table.

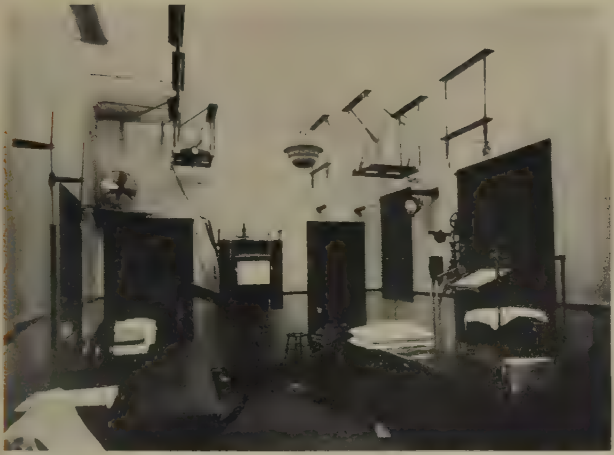


FIGURE 370—The fluoroscopic room, North Chicago Hospital. The indirect luminaire on dimmer control is ideal for this important department of the hospital.

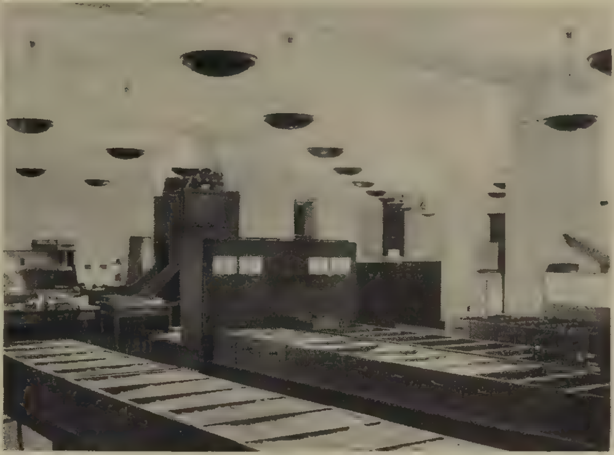


FIGURE 372—The filing department of Mayo Brothers' Hospital, Rochester, Minn. The lighting was planned identically as for commercial business offices.

Miscellaneous Rooms

There are many rooms in a hospital which require special lighting, such as laboratories, diet kitchens, preparation rooms, etc., each of which must be carefully studied because of the nature of its requirements. The offices should be given the same treatment as similar spaces in commercial buildings and supplied with generous indirect illumination.

Highly satisfactory results in the artificial lighting of the fluoroscopic room have been obtained by using totally indirect lighting with dimmer control. Since there are no sharp variations of intensity as the light is dimmed, the operator's eyes are not affected by sudden changes, and the work may be continued and readings made without a pause. He may readily inspect prints and negatives under low intensity indirect illumination, and then gradually increase to a higher value for examination of the patient, without experiencing the slightest ocular strain.

One of the rooms in the laboratory of Drs. Ferree and Rand is illustrated in Fig. 373, where a flexible system of indirect illumination has been installed to give a wide range of possible intensities of light in the room. It is in this laboratory that the valuable contributions to science relating to the effect of light upon the eye have been worked out by these famous scientists. For references to their researches see page 46.

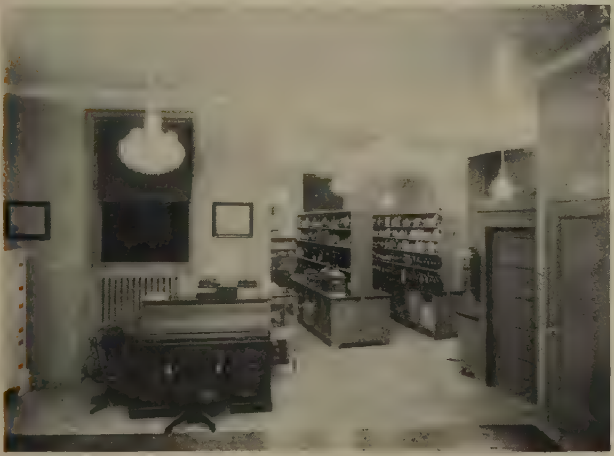


FIGURE 371—Medicine supply room, Presbyterian Hospital, Philadelphia. The chance of mistakes in reading labels is reduced to a minimum with diffused indirect lighting.

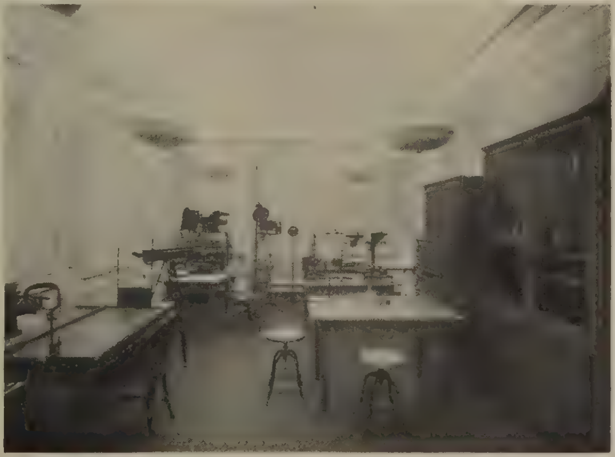


FIGURE 373—Typical room in the laboratory of Dr. C. E. Ferree, Wilmer Institute, Baltimore, Md. This laboratory is specially equipped for the study of the effect of light on the eye.

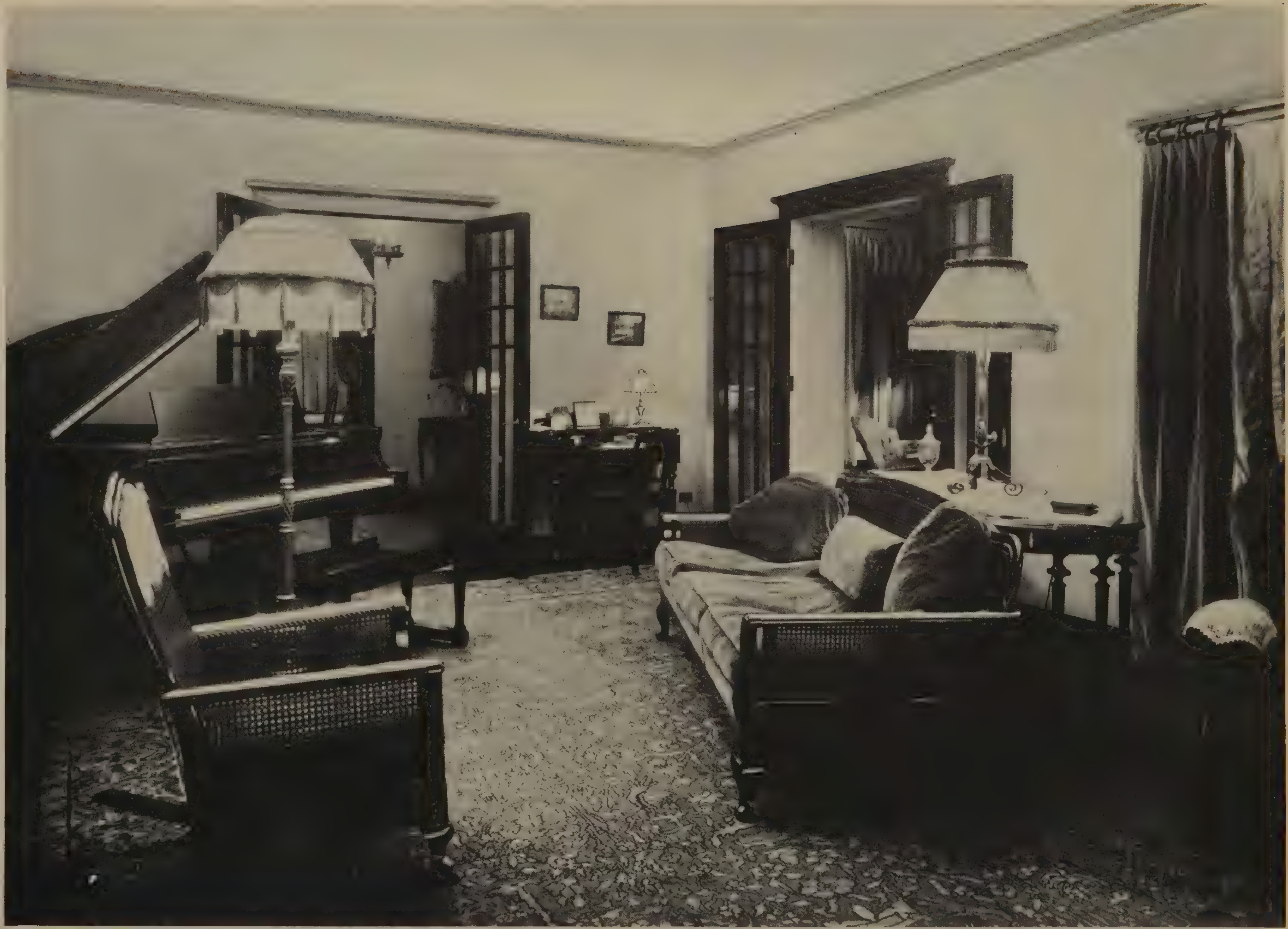


FIGURE 374—Living room in the residence of Mr. Frank A. Karg, Chicago, Ill. Carpenter and Weldon, Architects. Ceiling luminaires have been dispensed with. All of the illumination for the room is from portable lamps, two of which are of the indirect type, equipped as shown in Fig. 376.

RESIDENCES

WE HAVE a medium in modern lighting that has the most amazing possibilities for comfort, cheer and decorative effect in the home. The home is such a vital factor in our lives, its influence is so far-reaching, that anything which will make it a more livable place should have our serious thought. Modern lamps are so much more adequate than the devices that were placed in the hands of our ancestors, that by their means we can make the most commonplace cottage become a place of life and beauty, more than a mere place of habitation.

In the home, as in the school, good lighting must be used to conserve the eyesight of the growing child. With the incandescent lamp much light is concentrated in a very small space, so that the eye cannot look at it without discomfort. The first requirement in home lighting, therefore, is to shade all lamps to protect the eye from its crude harshness and diffuse its dangerous brilliancy. We do not often stop to consider how much of the content in our homes may arise from the character of the lighting. We may be soothed or keyed up by lighting alone.

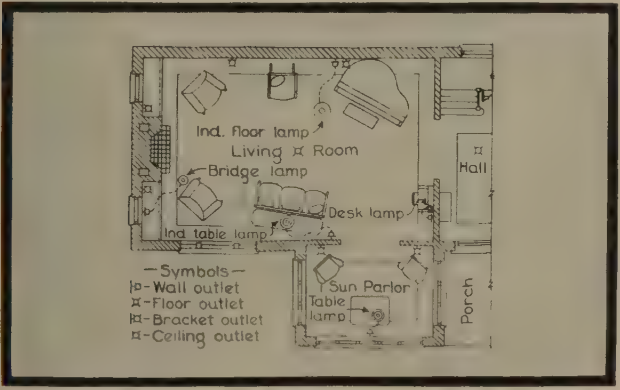

Ind. floor lamp
Living ¤ Room
Bridge lamp
Desk lamp
Ind table lamp
Hall
Sun Parlor
Table lamp
Porch
—Symbols—
-Wall outlet
-Floor outlet
-Bracket outlet
-Ceiling outlet

FIGURE 375—Plan of the living room in the Karg residence, showing arrangement of electrical outlets and relative position of the portable lamps.

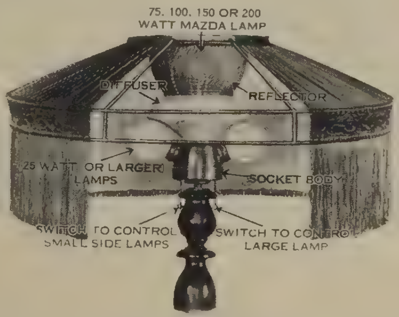

75. 100. 150 OR 200 WATT MAZDA LAMP
DIFFUSER
REFLECTOR
25 WATT OR LARGER LAMPS
SOCKET BODY
SWITCH TO CONTROL SMALL SIDE LAMPS
SWITCH TO CONTROL LARGE LAMP

FIGURE 376—Cutaway view showing how the Curtis portable indirect adapter is concealed inside the silk shade to give a double lighting effect.

Good lighting is no longer an item that belongs to the luxury class. It is within the reach of all. None can afford to neglect its benefits. Good lighting can be obtained in the home without the use of elaborate or special fixtures calling for a large outlay of money. As a matter of fact, good lighting fixtures may be obtained for much less than a good painting or other simple items of furnishing that make the home attractive. The operating cost may be less than the cost of our daily cereal cream or of a simple pudding.

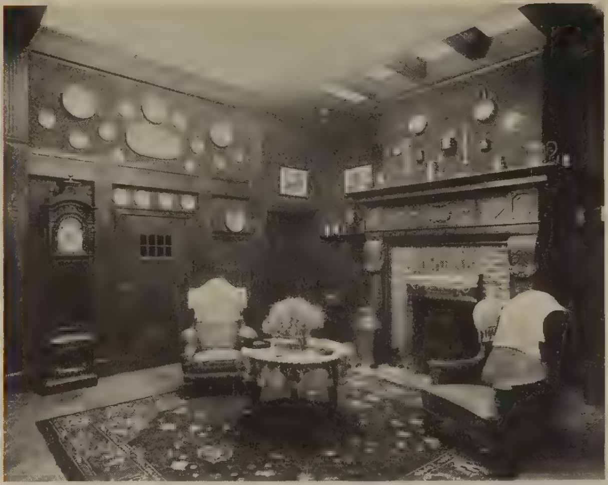


FIGURE 377—Room in the residence of Mr. Max Engestrom, Malmo, Sweden. The illumination is from a central indirect luminaire of brass containing X-Ray reflectors for indirect lighting.

We should not be satisfied in thinking that the use of a lighting fixture ends in producing only the general illumination. No doubt the day is not far off when we will decorate with light as easily as we now decorate with pictures and draperies. It is a most effective way of adding charm and beauty to the home. The use of tinted illumination is rapidly becoming one of the most important factors in home decoration. Yellow, orange and rose especially give mellow and pleasing effects. Yellow or amber lighting is the least tiring to the eye, and well adapted to use in the home.

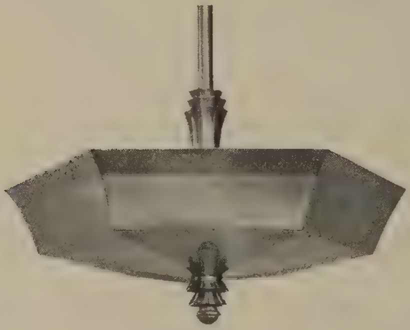


FIGURE 378—A luminaire especially designed for indirect illumination in residences.

The entrance or hallway should have lighting that will radiate friendliness and good cheer, whereas the predominant thought in the living room is to promote restfulness, with flexibility in the lighting for all occasions. The living room is the center of home and social life. Very frequently it suffers in appearance and comfort because of its lighting arrangements. Reading is often accompanied by a feeling of discomfort. Darkened and shadowed areas make portions of the room useless at night. Flexible lighting should be planned for every living room, since there are occasions when a generous flood of light is required. At other times the illumination must be subdued and restful. A proper lighting arrangement may include a ceiling luminaire, wall brackets properly shaded, and a number of portable lamps. Whatever the selection, the lighting should be capable of being varied according to the activities of the occupants and the moods desired.

In the lighting of the home no attempts are made to establish definite rules, since each household has its own individual characteristics. In the living room shown in Fig. 377, for example, general lighting is obtained by means of an indi-

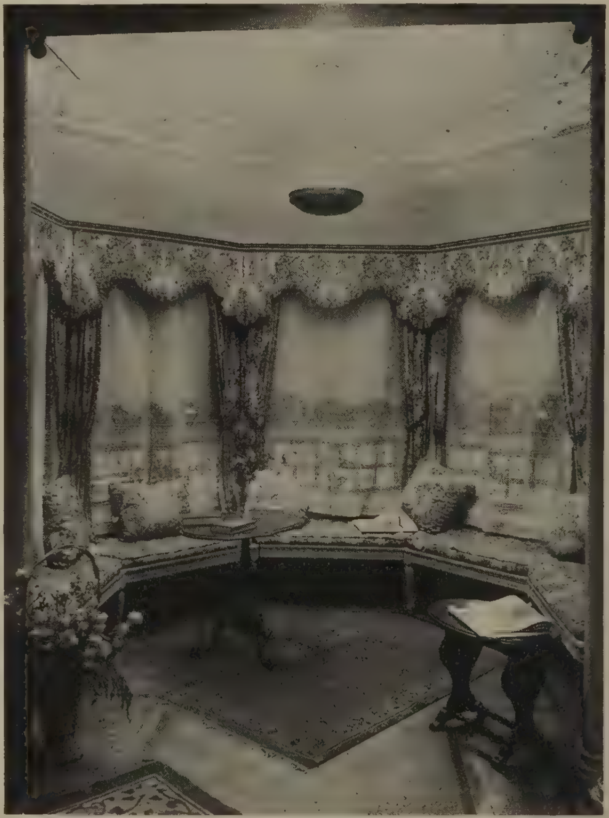


FIGURE 379—A sun room in a residence, appropriately lighted by an indirect fixture, with a multiple of lamps for varying intensities.

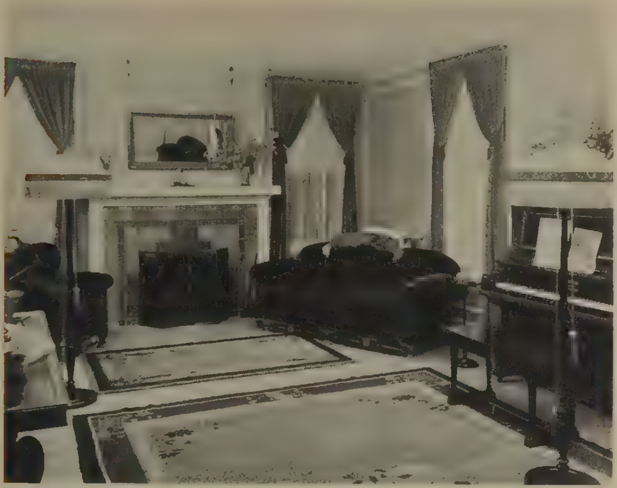


FIGURE 380—Living room in the residence of Mr. Romaine W. Myers. Two indirect portables, one at the piano and another at the library table, give just the right atmosphere.

rect ceiling luminaire, whereas in the room in Fig. 374 all the lighting is obtained from two portable lamps equipped with a Curtis adapter.

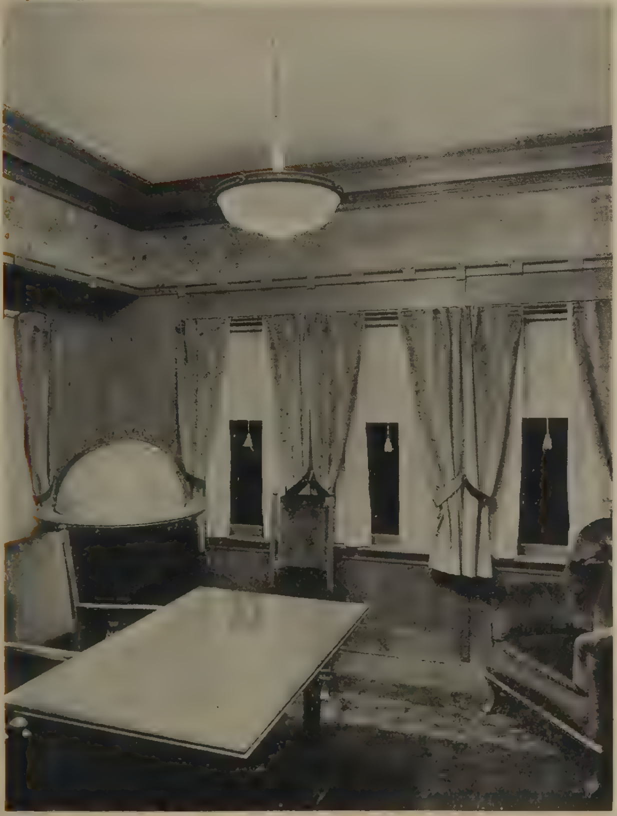


FIGURE 381—Library in the residence of Mr. Lindemann, Milwaukee, Wis. A luminous bowl type indirect lighting fixture is used.

The Curtis portable adapter heralds a general use of the art lamp in the home, inasmuch as it provides a double lighting effect from the same unit, and eliminates the necessity of using ceiling fixtures or ceiling outlets. In addition to giving a local lighting like the ordinary art lamp, the Curtis adapter completely lights the entire room with soft, diffused, indirect illumination.

In Fig. 376 we see a cutaway view of the Curtis adapter fitted to a lamp pedestal. One of the switch chains operates the lamp for local lighting on the table, while the other is for the lamp in the X-Ray reflector which projects the light to the ceiling. When the small auxiliary lamps are turned out, the diffuser in the bottom of the reflector lights the shade with a soft glow.

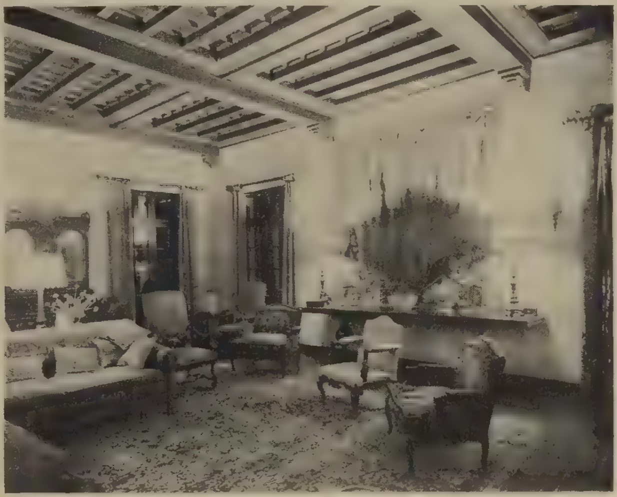


FIGURE 382—Italian living room in a large residence, illuminated entirely by art lamps equipped with indirect adapters.

In the side sockets 15 and 25-watt lamps may be installed, according to brightness of the local light desired. For the socket inside of the reflector a 100, 150, or 200-watt lamp may be used. One hundred watts will amply light a space 14 feet square; 150 watts will illuminate a space 15 by 18 feet; and the 200-watt lamp will take care of a room 18 by 20 feet. Any lamp shade having an opening at the top of 6¾ inches in diameter or more may be used with this unit. Being mostly indirect, the light from this lamp is better diffused and distributed than by the ordinary candle or pendant fixture.

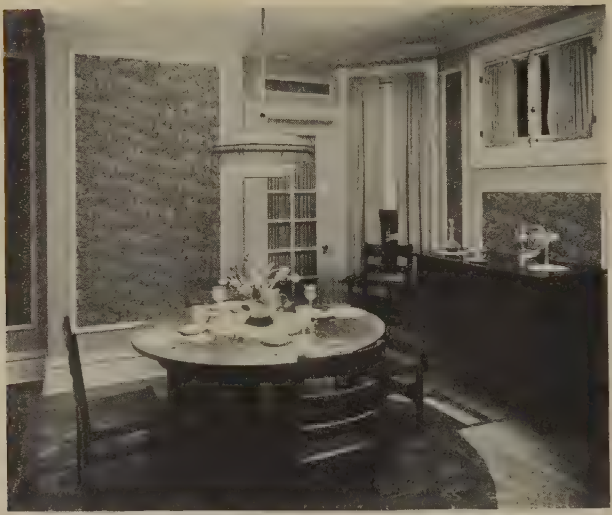


FIGURE 383—Dining room in a residence, illustrating the use of a luminaire especially designed for dining room lighting.

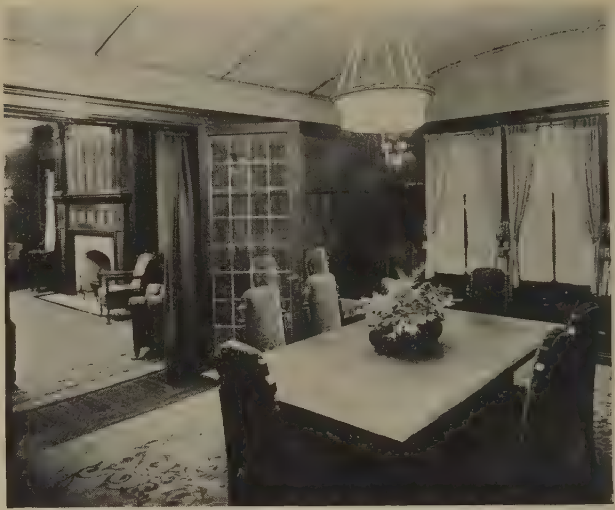


FIGURE 385—Dining room in the residence of Mr. Lindemann. The indirect luminous fixture supplies proper lighting.

The dining room is, probably, the most difficult room in the house to illuminate, because of varying tastes. Some prefer the use of a simple ceiling fixture, while others resort to bracket lighting only. Here, again, the householder must decide for himself just what type of lighting is most suitable. The examples shown illustrate some interesting variations. In Fig. 383 is a luminaire designed especially for dining room lighting, giving first a strong directed light upon the table to emphasize the table setting. This light is carefully shaded from the eyes of the diners. In addition, the fixture provides a general diffusion of indirect illumination throughout the room by reflectors which cast their light upward to the ceiling. A third interesting variation is a tinted or "complexion" lighting, which is transmitted through the body of the unit upon the faces of those seated at the table. Thus we have in this fixture three lighting effects, each of which may be separately switched.

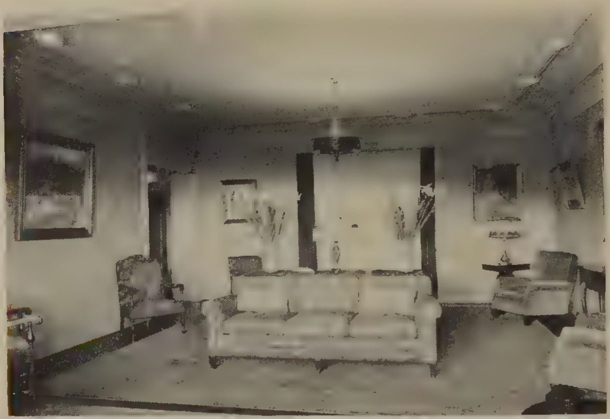


FIGURE 384—Living room in the residence of Mr. John Hubert Mee, San Francisco. The general lighting is from indirect luminaires, supplemented by X-Ray reflectors for illuminating the paintings.

A very interesting and special arrangement in home lighting was planned by Mr. J. R. Cravath for a residence in California. The chief problem was that of combining in a pleasing manner for several rooms of the house the principles of art

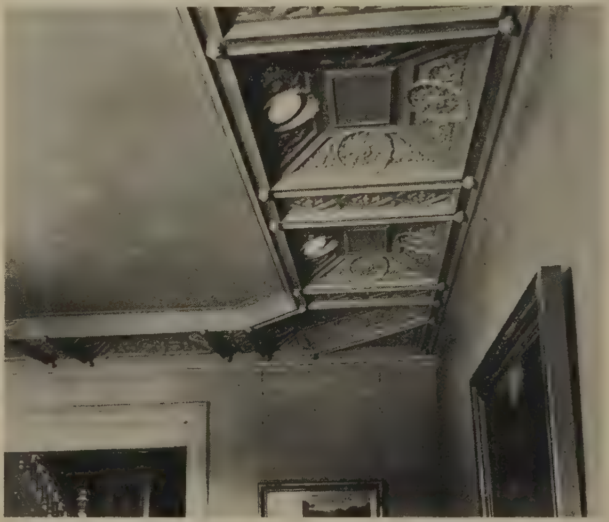


FIGURE 386—Close-up view of the picture lighting in the dining room in the residence of Mr. Mee.

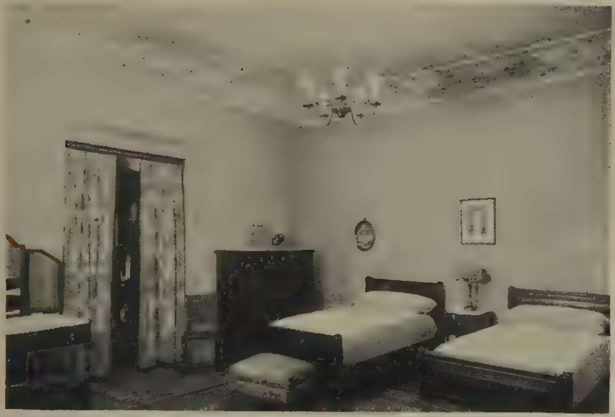


FIGURE 387—The luminaire in this bedroom is equipped with candle adapter reflectors, giving effective and comfortable lighting of maximum efficiency.

gallery lighting and those of home lighting. The illumination of the rooms in the conventional way by indirect fixtures was given serious consideration, but it did not fulfill the requirements where emphasis was being placed on picture lighting. Enough light could be provided for adequate visibility of the pictures, but it was desired that the painting be emphasized.

The study of the problem led to the modification of the ceiling to permit reflectors being placed as shown in Fig. 386. The ceiling of the room was specially designed as to contour and dimensions to take the necessary recessed equipment. X-Ray reflector units for 40-watt inside frosted lamps were installed in the space between the ceiling joists. The opening through which the light comes is covered with a circular glass plate of proper diffusing quality.

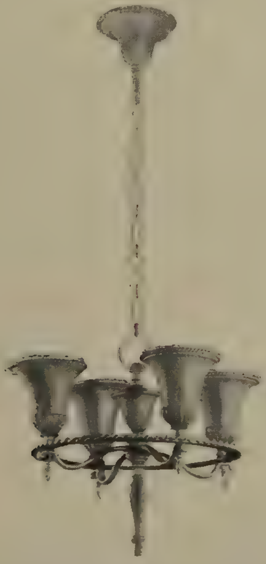


FIGURE 388—Luminaire appropriate for home lighting. The bellshaped spinnings conceal X-Ray reflectors for indirect illumination.

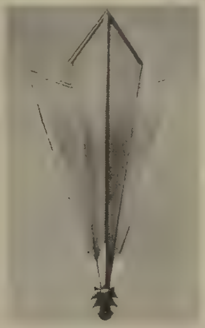


FIGURE 389—A wall bracket in modern art design, appropriate for the bedrooms and hallways of the home.

In such rooms as kitchens, pantries, ballrooms, etc., we can more nearly standardize lighting usage, but for other portions of the home the owner must devise his own rules, keeping in mind that every room of the house has a particular purpose and a particular meaning, and that the lighting can be made to emphasize this. The kitchen lighting, for example, is more utilitarian than artistic, but here good, diffuse, well distributed illumination should be provided, with a generous intensity and the elimination of shadows. There is no limit to the ways in which light may be used for comfort and decoration in the home.

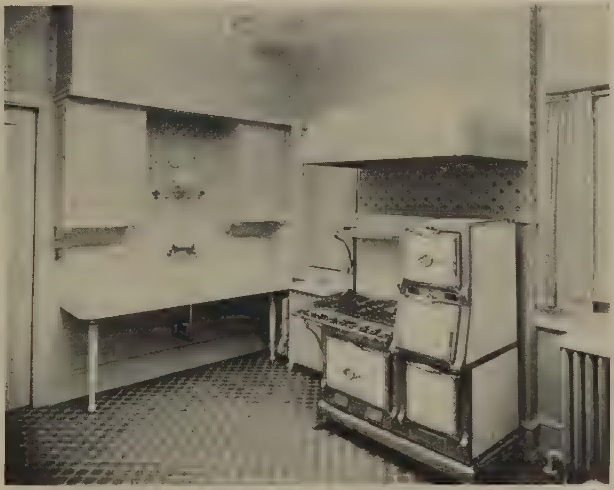


FIGURE 390—The effective use of indirect lighting in the kitchen is shown here.

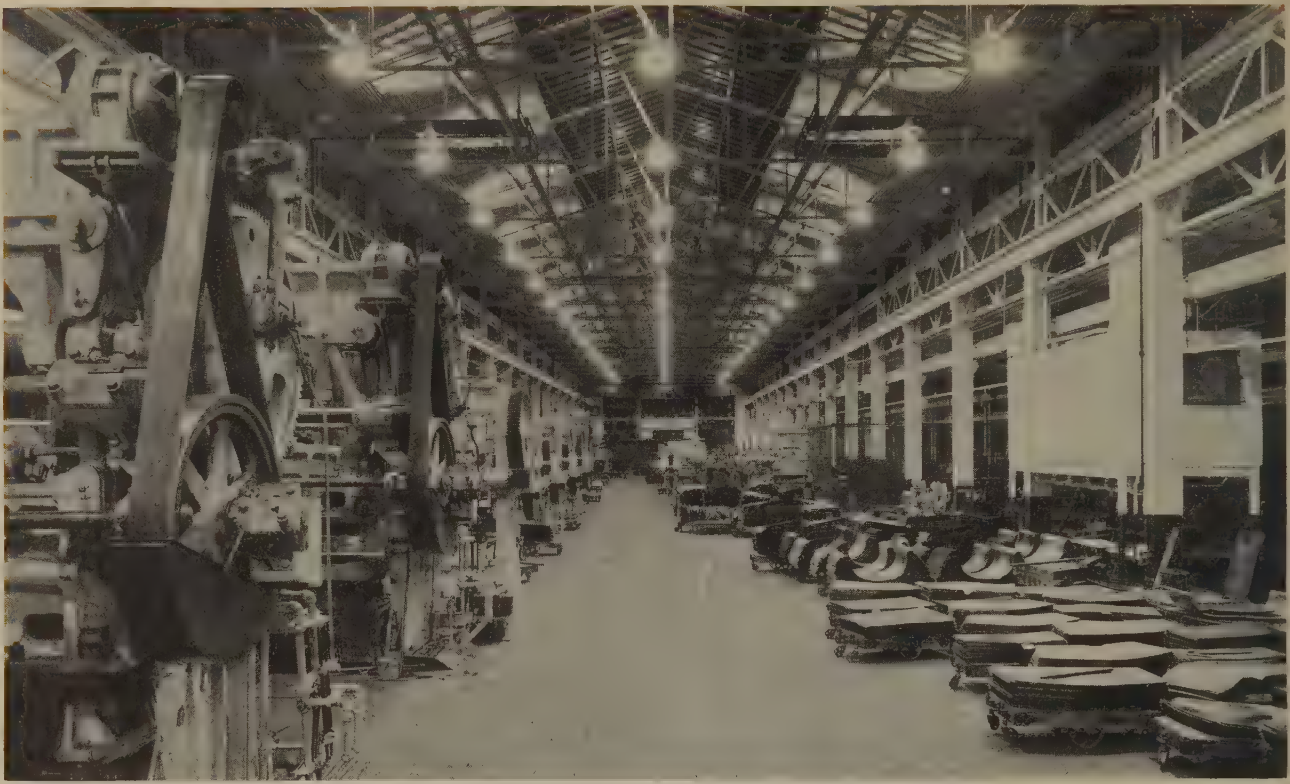


FIGURE 391—Stamping room in the plant of a large manufacturer of automobile bodies. Typical example of effective high bay lighting with X-Ray reflectors of the type shown on page 211.

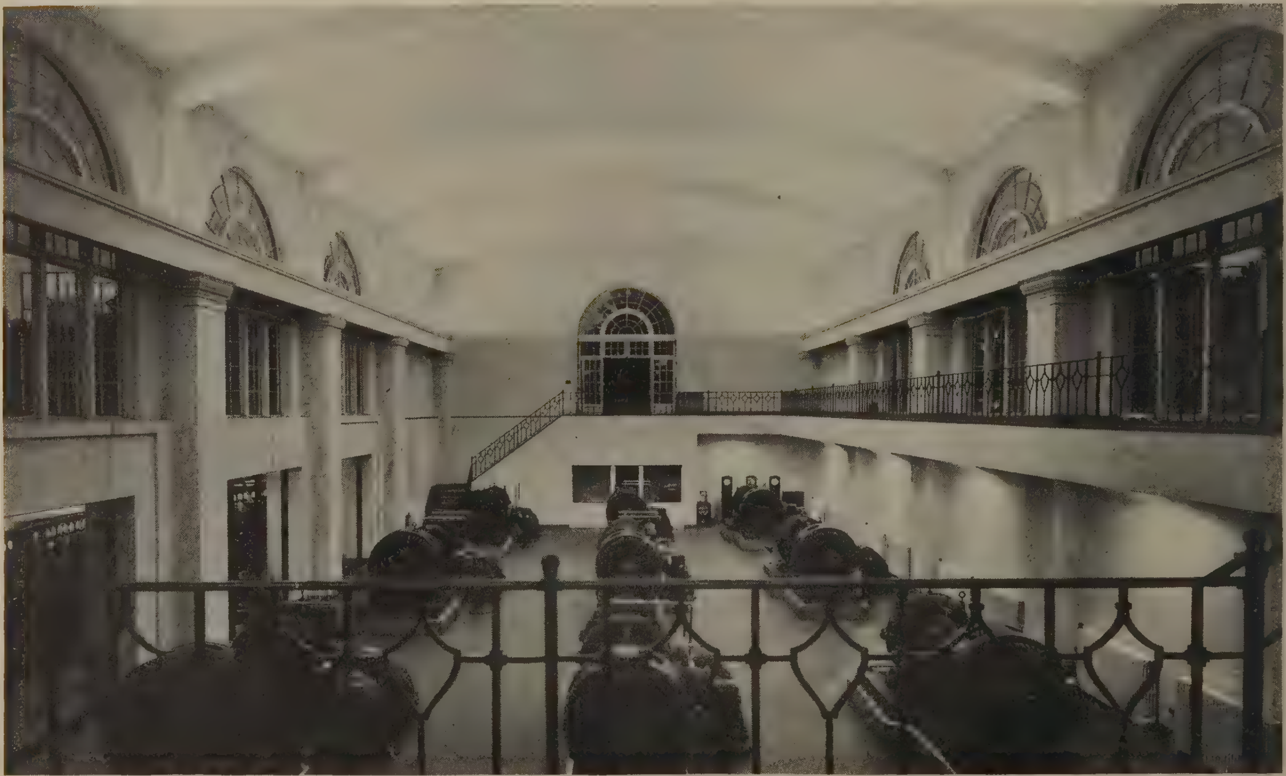
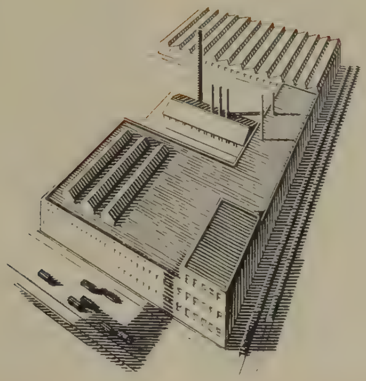


FIGURE 392—Cove lighting from crane rail in filtration plant for the Capitol City, at Washington, D. C. The building was designed by U. S. Army engineers.



INDUSTRIAL BUILDINGS

IT HAS been proved beyond a doubt, by careful investigations and tests under practical working conditions, that good lighting in industrial operations increases the output of manufactured materials. The engineers who put the lighting in a woolen mill found, by changing the system from an old style to one that produced no eyestrain, that the production of the manufacturing division was increased twenty per cent.

Furthermore, good lighting decreases the percentage of defects and spoilage. It results in a noticeable lowering of the accident rate and a reduction of injuries. The worker benefits in an environment which is more conducive to health and eye comfort. There is an improvement in morale. The foreman finds that the problem of supervision is much more simple. Labor turnover is decreased. Altogether, good lighting reduces the unit cost of production, hence the manufacturer regards lighting less and less as a necessary evil and more and more as an agent of thrift. He knows that the economics of production demand the utilization of every reasonable means to produce more and better goods at less cost.

One-third of all manufactured goods is made under artificial illumination. Some factories need artificial light all of the time. Every plant must use it part of the time, because there are gloomy, dark days, days when the sun does not shine.

Statistics show us that only a small percentage of our factories have truly good lighting, as judged by modern standards. The others are suffering in production losses, spoilage, accidents, waste and labor turnover, which could be avoided by the simple process of eliminating eyestraining glare, putting enough light everywhere, and installing proper reflectors. More usable light per lighting dollar may easily be obtained, and the many benefits of good illumination be received.

The proper kind and quality of light in an industrial plant enables the worker to see clearly, while a generous amount of illumination speeds up the seeing process and helps the worker to distinguish detail more quickly. The effect of light upon vision has been discussed on page 47, and is shown by an interesting diagram in Fig. 41.

Several states have recognized the beneficial effects of correct artificial lighting on the health

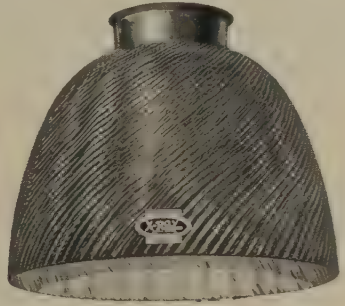


FIGURE 393—Typical X-Ray "Beehive" reflector. This type ranges in capacity from 50 to 1500 watts, and is applicable to every type of factory and shop interior.

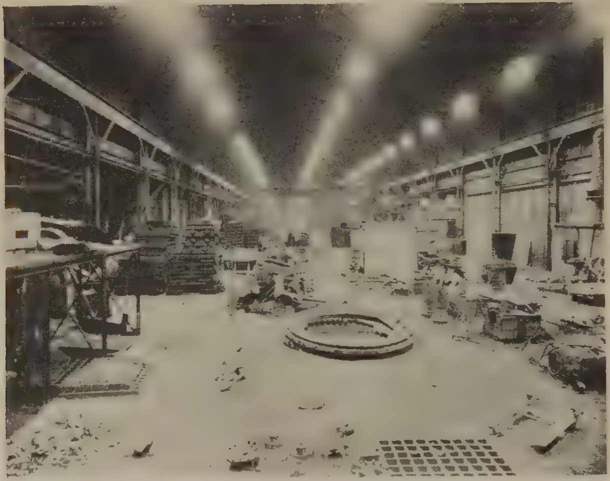


FIGURE 394—Foundry of the Crucible Steel Company, Milwaukee, Wis. Excellent lighting in a busy shop with 750-watt lamps in X-Ray reflectors.

and safety of employees, and have adopted regulations for factory lighting which stipulate the minimum amount of illumination permissible for various locations and for different operations.

Typical of the large interiors of modern industrial establishments is the stamping plant of an automobile body manufacturing corporation illustrated in Fig. 391. Ample intensities of lighting are supplied from overhead units suspended from the roof structure just above the crane. In this particular installation the ceiling is 39 feet high. The lighting units are spaced about 20 feet apart and consist of a large X-Ray reflector, similar in style to that shown in Fig. 211, and designed for the 1500-watt incandescent lamp. Modern plants, in which the speed and cost of production are of vital importance, use high intensities of artificial lighting. In this plant 26 foot-candles of illumination are uniformly distributed over the area.

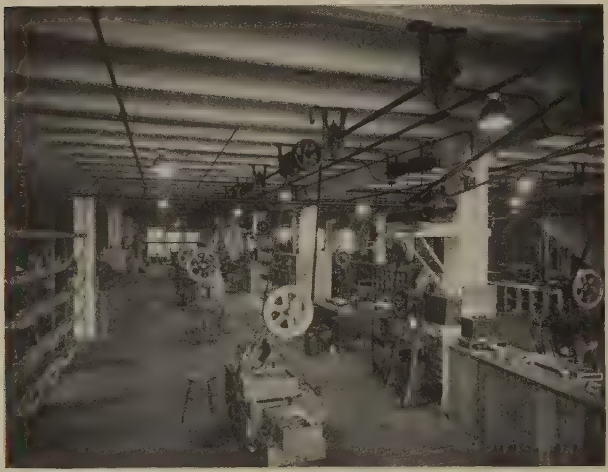


FIGURE 395—Punch press department of the Irving Pitt Manufacturing Company, Kansas City, Mo.

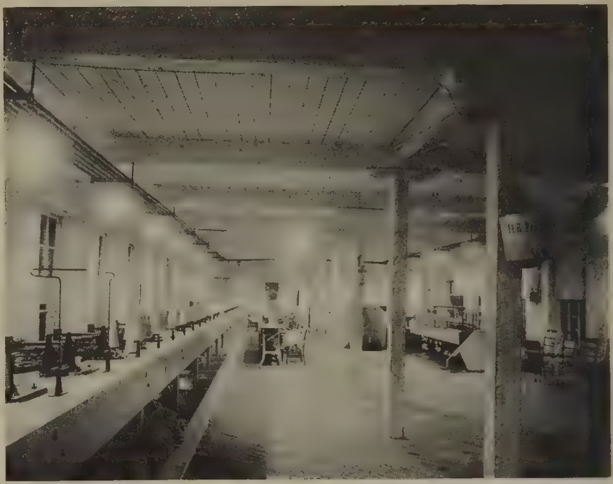


FIGURE 396—A room in the mill of the F. Y. Kitzmiller Company, Bechtelsville, Pa. Lighting units are localized over the work tables.

The Capitol City of the United States at Washington, D. C., has an ideal filtration plant for its water supply. The system was designed by U. S. army engineers, and is an example of what may be done to make an industrial plant a thing of beauty as well as of mechanical efficiency. The interior of the power house is illustrated in Fig. 392. Taking advantage of the space occupied by the crane rail, lighting units with X-Ray reflectors were hidden from view, and so placed as to cast their light evenly over the ceiling area, giving an

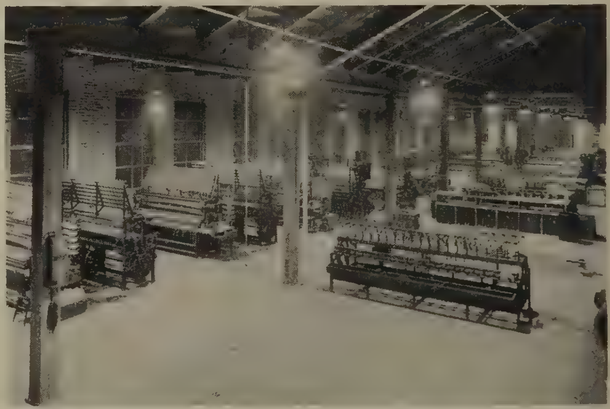


FIGURE 397—Factory of the R. J. Ederer Fish Net Company, Chicago. Strong intensity lighting, well diffused.

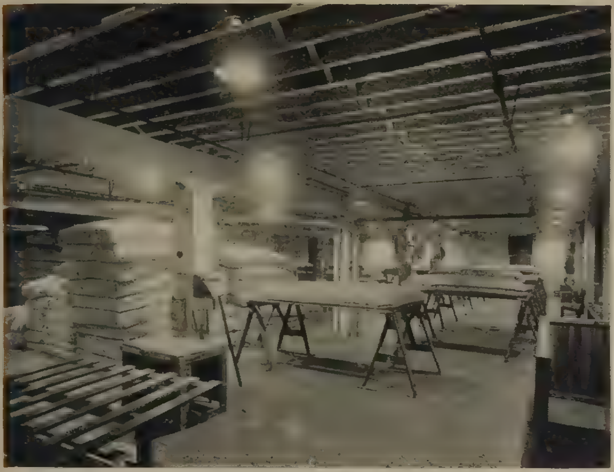


FIGURE 398—Direct lighting in the mattress department of the Louisville Bedding Company, Louisville, Ky.

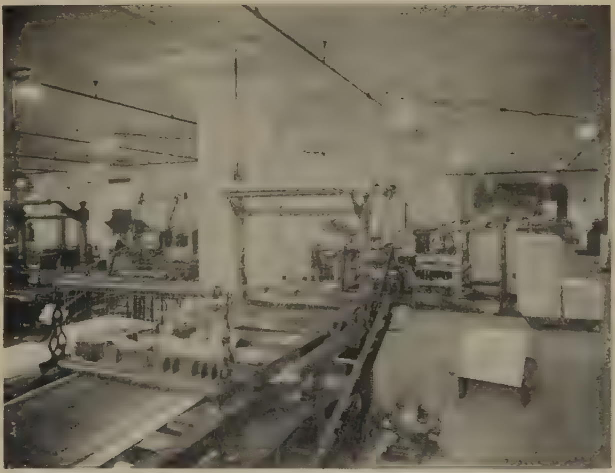


FIGURE 400—General illumination from overhead units in the ruling machine department of the Irving Pitt Co., Kansas City.

indirect lighting for the room of an especially suitable and desirable character for this type of plant. The crane rail, ordinarily unsightly, is enclosed by a boxing, which also serves as an enclosure for the lighting units. A similar system of lighting was installed in the filtration rooms illustrated in Fig. 228.

In many industrial plants there is necessity for a scheme of lighting which may be designated as a localized general system; in other words, an arrangement and spacing of lighting units to give a good general illumination throughout the room and yet concentrate the maximum lighting at definite locations. This point is illustrated clearly in Fig. 396, where it may be seen that the rows of X-Ray reflectors are spaced with reference to the work tables, and suspended at such a height that the lamps will be entirely out of range of vision and yet be so situated that most of the lighting will fall upon the work just where it is needed.

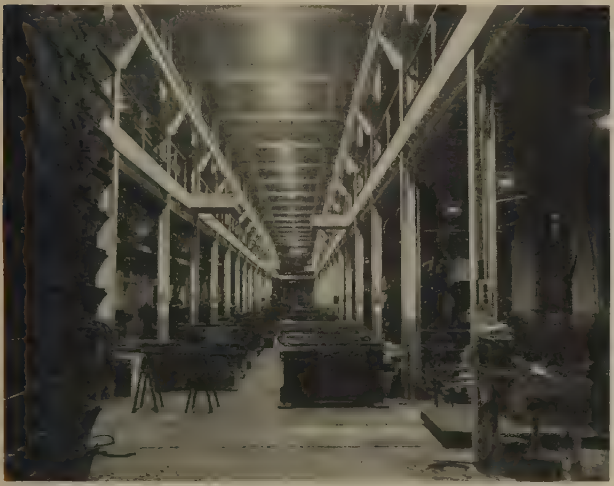


FIGURE 399—High, narrow bays in the plant of the Modern Tool Company, Erie, Pa., are effectively lighted by reflectors like those shown on page 211.

The making of fish nets is a rather unique business, and requires special machinery, as may be seen from the illustration in Fig. 397. Like other industries in the textile field, it is extremely necessary to detect immediately the breaking of a thread. This cannot be done, of course, without proper and sufficient lighting. The manner and means of supplying a high degree of illumination

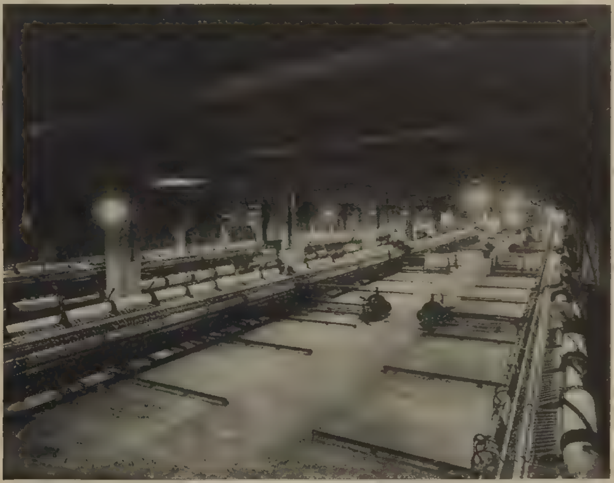


FIGURE 401—Direct lighting in the plant of the Stevenson Underwear Mills, South Bend, Ind.

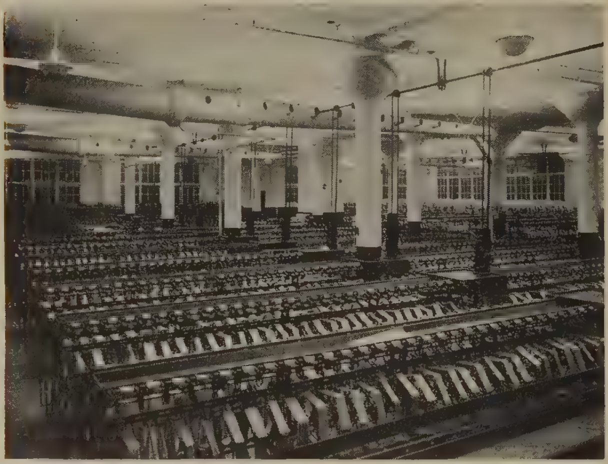


FIGURE 402—Silk mills, Klotz Throwing Company, Passaic, New Jersey.

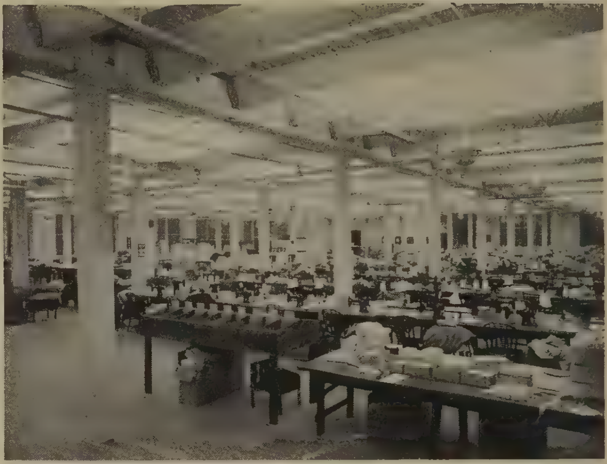


FIGURE 405—Indirect illumination is ideal for many work rooms.

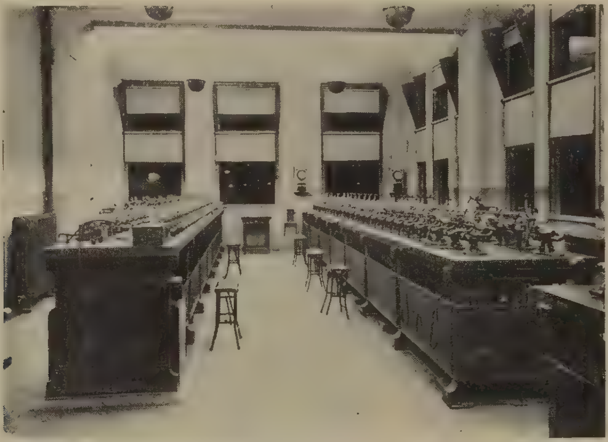


FIGURE 403—Diamond cutlery, I. J. Asscher, Amsterdam, Holland.

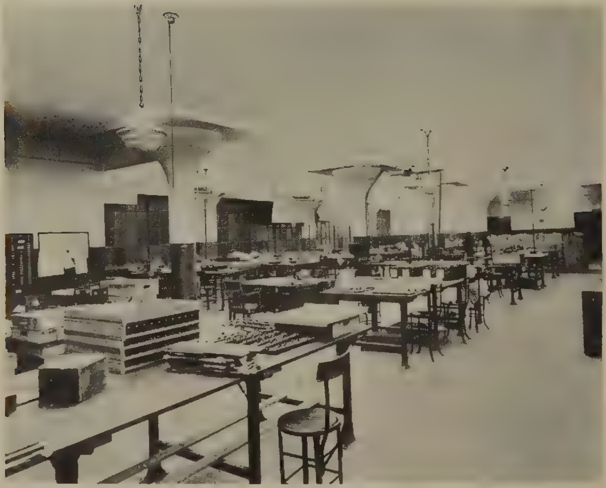


FIGURE 404—Factory of Grebe Radio Co., Richmond Hill, N. Y. Glareless lighting.

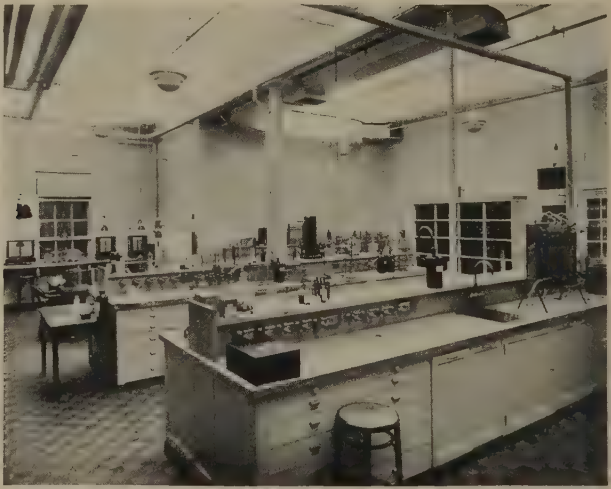


FIGURE 406—Chemical laboratory of Warner Brothers, New York, N. Y.

for this type of industry are illustrated. The X-Ray reflector No. 580, with 500-watt lamps spaced on comparatively close centers, gives a type of lighting that is ideal for intricate operations.

Many of our industrial shops have extremely high bays, frequently running through two and three floors, and having heights of 50 to 80 feet. These high and narrow areas introduce a rather different lighting problem. For this particular purpose a special high-bay lighting reflector has been designed. It is illustrated in Fig. 407, and gives a distribution to the flux from the lamp that is particularly suitable. The light is delivered in a semi-concentrated manner, sending a maximum of illumination to the floor, disbursing as little as possible sideways to be absorbed by walls, steel structure, etc. Fig. 399 illustrates an area that is illuminated with this type of unit. Note particularly the evenness of the distribution of light and the lack of shadows.

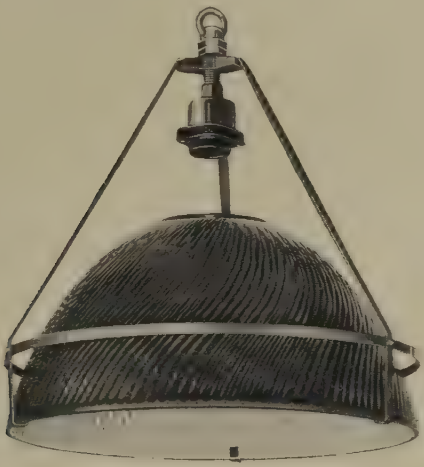


FIGURE 407—The "Big Boy" X-Ray reflector, designed especially for the illumination of high bay industrial interiors. It is used with 1000 or 1500-watt lamps.

Manufacturers and superintendents of plants are aware of the fact that the more nearly the lighting approaches daylight conditions, the greater will be the production and the lower the cost of manufacturing. Although direct lighting by careful planning will give satisfactory results as far as distribution of light is concerned, it cannot equal in diffusion the illumination received from the indirect lighting system; therefore this latter method is receiving much consideration from plant managers.

Even though conditions are not ideal for use of indirect light as regards the matter of the ceiling, the managers of the plant shown in Fig. 405 could find no direct system which would give them just the lighting results that they desired. The great number of sewing machines would require an extensive system of localized units to provide the operators with the proper illumination. The questions of direction, elimination of shadows, intensity, diffusion, and lack of glare were simultaneously taken care of once the system of indirect illumination was installed.

The upkeep of the lighting equipment is just as necessary as the washing of the windows or the replacing of wornout machine parts. It is, therefore, important that a regular schedule of maintenance be adopted, since accumulations of dust and dirt on equipment very much reduce the efficiency of the lighting. Reflectors and lamps should be thoroughly cleaned at least once every two

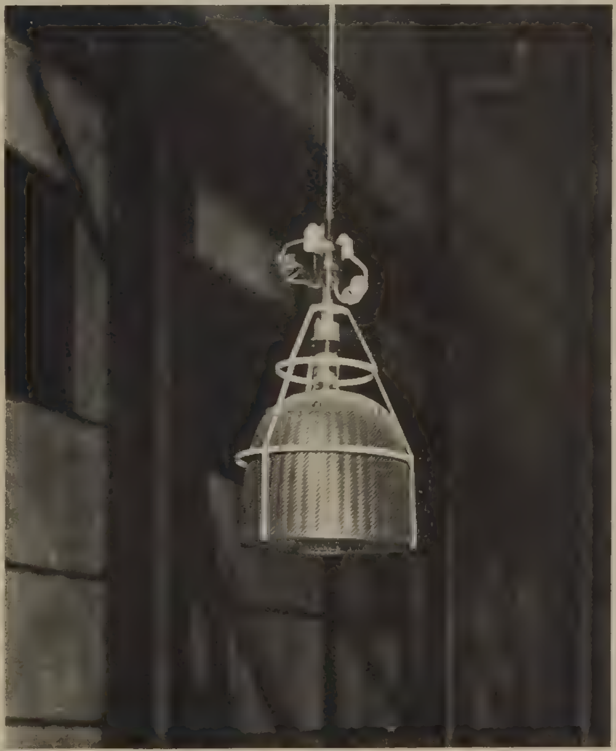


FIGURE 408—The "Jumbo" X-Ray reflector as used in the American Cast Iron and Pipe Company, Birmingham, Ala. The lowering device simplifies maintenance.

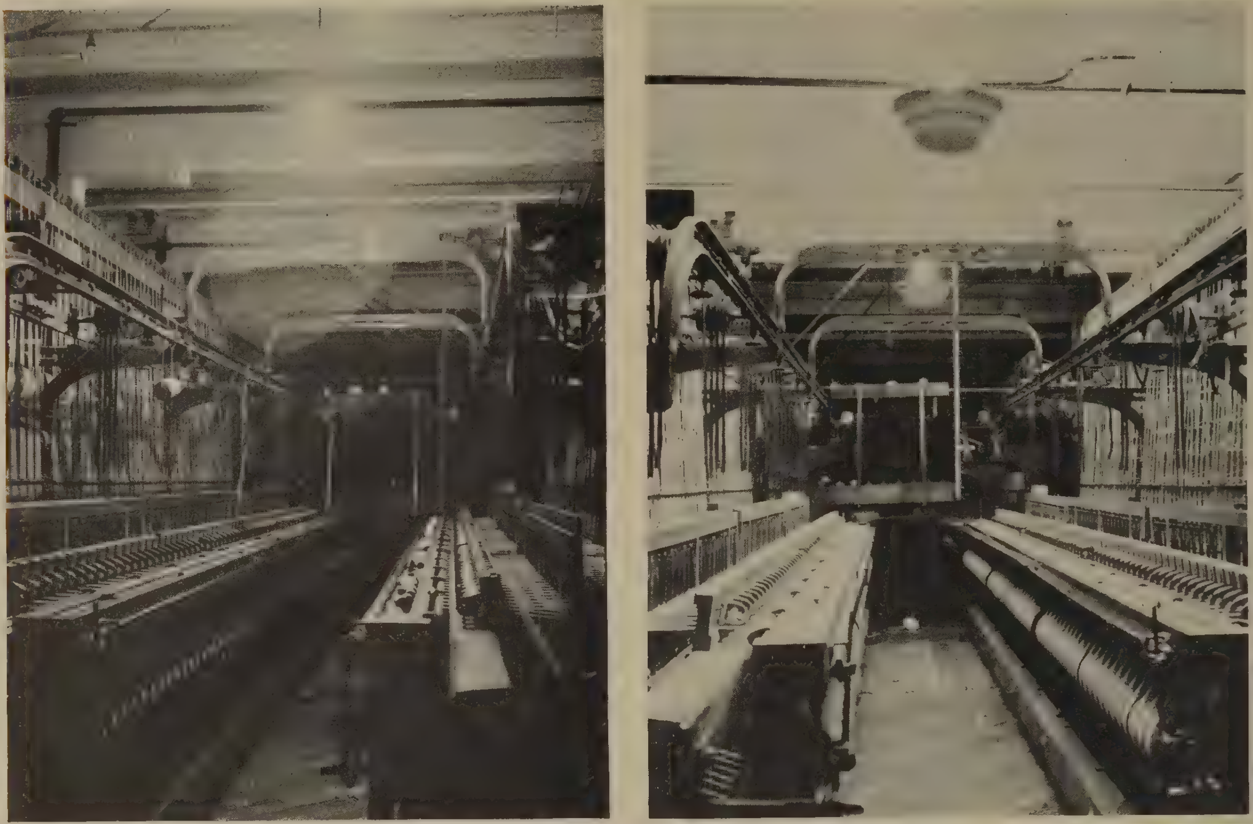


FIGURE 409—A loom in the plant of John Sidebotham Mills, Philadelphia, Pa., employed in a test to determine effect of lighting conditions on production. Glaring lighting, as shown on the left, decreased production, while well diffused illumination, as shown at the right, resulted in an increase in the output of the plant.

months if the satisfactory average is to be maintained that is shown in Fig. 57. In almost every case the equipment is installed on moderately high ceiling, more or less difficult of access from the floor. It is, therefore, desirable that the complete lighting unit be brought down to the floor for cleaning and renewal of lamps. In Fig. 408 we see one of the X-Ray "Jumbo" lighting units of the American Cast Iron Pipe Company, Birmingham, Alabama, lowered within easy reach of the maintenance man. Ordinarily, the reflector is 36 feet from the floor, and it is difficult to get at even on a tall ladder. By the simple expedient of a disconnecting hanger the question of accessibility is easily solved.

Quantity and quality are the two factors to be most emphasized in selecting a system of illumination for an industrial plant. A striking example of the importance of quality is afforded in the plant of John Sidebotham Mills, of Philadelphia, manufacturers of high grade tape for insulating purposes. The results of an important investigation in the weaving department were recently discussed in an article by Mr. Arthur A. Brainerd, of the Philadelphia Electric Company, and two views of the looms used for the experimental lighting are shown in Fig. 409. Since the looms were running about 65% of the time, it is evident that good lighting is essential. The original system of illumination consisted of two 75-watt bare lamps on drop cords. The usable illumination was not more than 5 foot-candles on account of shadows cast by projecting portions of the looms and by the operator's body.

The first natural step in improving the illumination was to increase the intensity of the light. This was accomplished by using 300-watt lamps in an improved style of metal reflector. It seemed

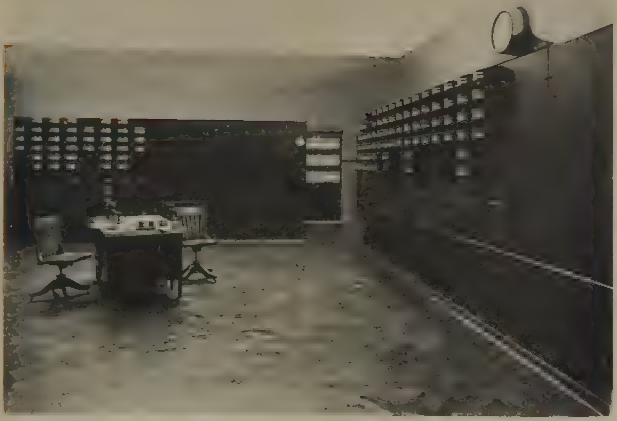


FIGURE 410—Control room in substation of New York and Queens Electric Light and Power Company, Maspeth, Long Island. See Fig. 412 for details of the lighting system.

that production conditions were not improved, because a high contrast glare was introduced by the larger lamps. The softening of the shadows was obviously necessary, therefore the next step was to equip the reflectors with enameled lamps. The increase in production with this arrangement was found to be almost 4% over the original installations. The results were not considered wholly satisfactory, so another arrangement of lighting, using totally indirect units with 200-watt lamps was installed. A study of the production under this system reveals some very interesting facts. Since the glare and shadows were practically eliminated, it was no surprise when the factory record showed an actual over-all increase of 7.7%. As the totally indirect system was delivering illumination of practically perfect quality, arrangements were made to increase the intensity. After careful analysis of the number of tests, the record showed that at 12 foot-candles the increase was 11%.

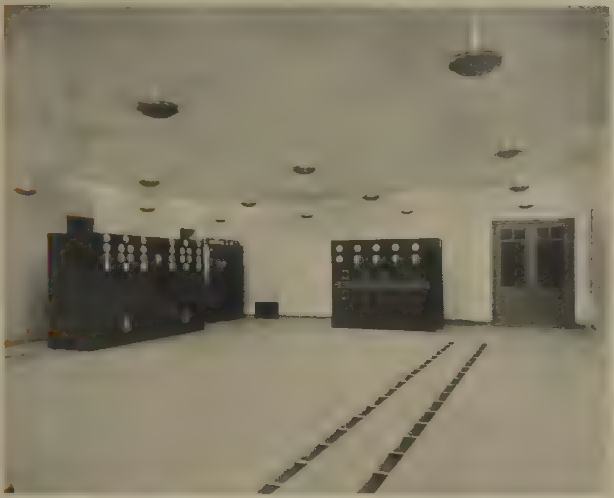


FIGURE 411—Control room, Montreal Light, Heat and Power Company, Montreal, Quebec.

A study of the results of these tests shows that under-production and discontent among employees were due entirely to harsh shadows, and not to low illumination. In fact, the intensity of illumination may be a meaningless expression unless care is taken to insure a quality of lighting that is consistent with the character of the work performed, the value of the product, and the wages of the operator.

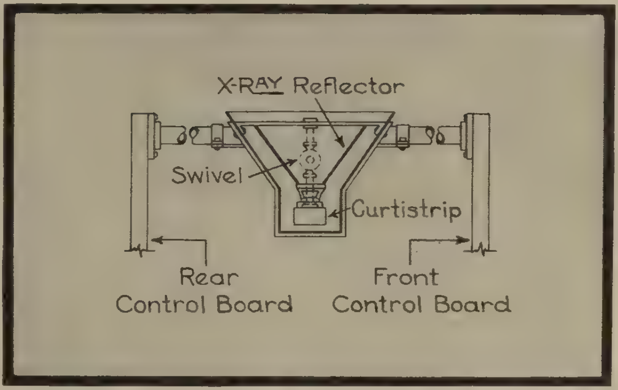


FIGURE 412—Diagram showing method employed for illumination of the control room of the New York and Queens Power Company.

Indirect illumination has been found to be particularly suitable for the lighting of switchboard rooms, control rooms, load dispatchers' rooms, etc. In the illustrations of Fig. 410 and Fig. 411 we have two interesting examples of this type of lighting, one of which employs a totally concealed equipment placed on the back of the switchboards, and from which the light is directed to the ceiling. In the other case, the Montreal control room, a shallow metal bowl type indirect fixture was installed with great success. The operator, who must be on the alert in watching the various dials of the meters, will be much handicapped and fatigued if any annoying reflections are cast by meter casings or the glass protecting the dials.

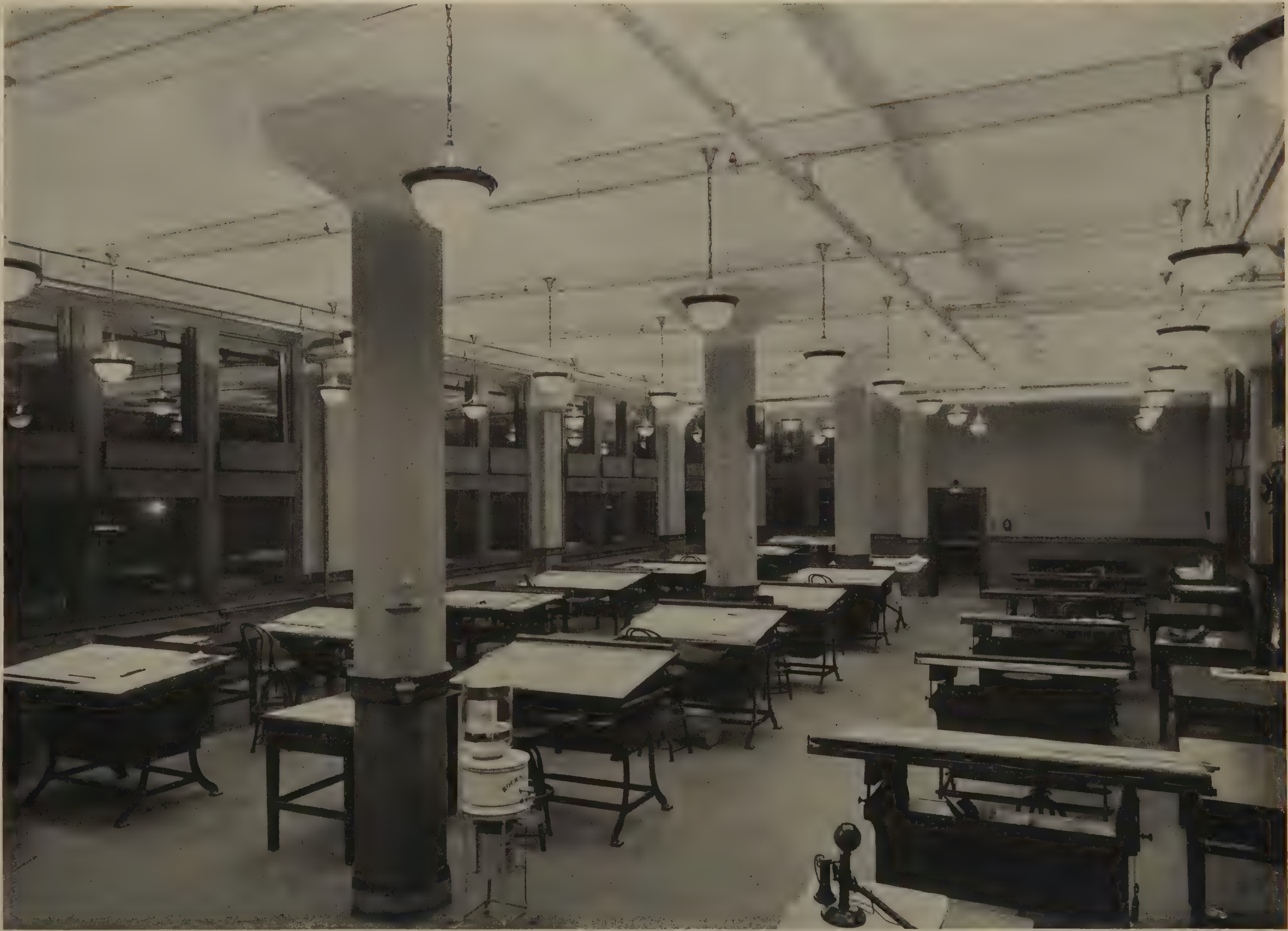
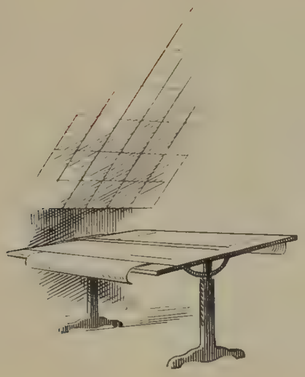


FIGURE 413—Drafting room of the American Can Company, New York, N. Y. showing satisfactory results obtained with indirect lighting. So diffuse is the lighting that, even under the tables, shadows are very slight.



DRAFTING ROOMS

EYE comfort is needed here, if anywhere. The drafting room is always the crucial test of any lighting system. The draftsman's vision must be conserved in every way possible, as the already great strain on his eyes incident to the fine, accurate work necessary, should not be increased by poorly designed lighting equipment.

Although the requirements of the drafting room are very exacting, if proper thought is given to the planning and location of the lighting units, practically ideal results may be obtained, with an even distribution of well diffused light throughout the entire room. The engineering executive of industrial establishments knows that it is to the interest of his company to provide conditions for the employees that are conducive to the greatest results at the least possible cost.

The uniform distribution of light obtainable from properly installed X-Ray indirect lighting fixtures has invariably won praise in the drafting room. As a practical means of conserving seeing power and maintaining the efficiency of the worker, and in turn the earning power of the employee, this method is enthusiastically endorsed by all those who must work under artificial illumination.

From careful research it has been found that eye fatigue under indirect lighting assumes the ratio of 1 to 4, as compared with direct lighting, at intensities necessary for work of this character; therefore it is apparent that the efficiency of the draftsman is increased in a similar proportion.

Shadows are not to be desired, especially on the edges of the T-square and triangle. On the other hand, the absolute elimination of shadows is also undesirable. It is sometimes thought that indirect lighting produces a shadowless illumination. This is not true, inasmuch as there is a directional effect to properly planned indirect lighting, giving very soft shadows similar to those produced by diffused daylight.

The day has passed for the use of localized lighting on the drafting table. We no longer find in the up-to-date drafting room drop cords or goose neck lamps over the tables. These not only produce strong contrasts in lighting, but are of frequent annoyance and menace to fellow draftsmen. With the indirect lighting system planned for general illumination the tables may be entirely cleared of lighting accessories, giving the room a neat appearance, and enabling the draftsman to work in any position without the necessity of adjusting his light. The use of indirect lighting permits the maximum flexibility in the arrangement of the drafting tables. Furthermore, the draftsman may work in any position, at the ends of the table or at the sides, as he chooses, always getting the light from the proper direction.

The critical test for artificial lighting comes when the daylight begins to fail. Lamps are

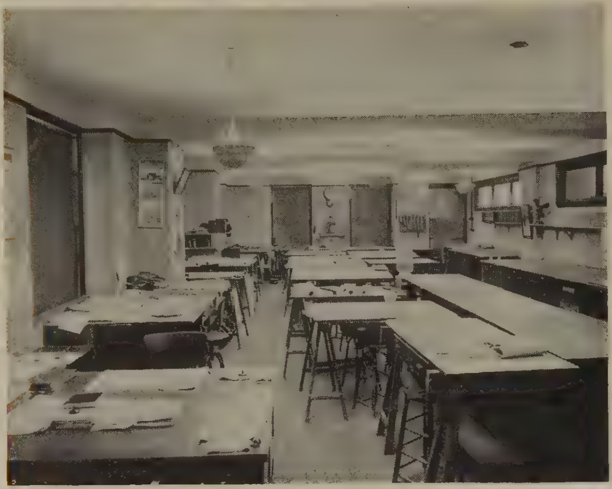


FIGURE 414—Drafting room of the Erie Railroad Company, New York, N. Y. Low ceilinged room in which opaque indirect lighting has been installed with complete satisfaction.

switched on. At first the illumination seems to be inadequate, but as darkness gathers the light becomes more satisfactory. At this time of day the drawing of the shades is frequently practiced in drafting rooms, so that the upper portion of the shade, especially, acts as a reflector, returning much of the light into the room that would ordinarily be wasted by transmission through the window glass. To properly compensate for this loss the window shades should be of light color, such as cream or tan. Venetian blinds of light color are also very efficient in this respect, and can be lowered and closed as the natural light becomes insufficient in quantity.

As regards the amount of illumination to be used in the drafting room, information is given on page 279. It should be made emphatic that a high intensity of light is necessary, higher than is commonly used for general office illumination. The nature of the work affords more opportunities for eye fatigue, more chances for the development of Opthiphosis. Values two or three times as great as used in offices should be provided.

The highest efficiency for the lighting installation in drafting rooms is obtained when the ceiling and side walls are finished in light tones. For the ceiling finish it is recommended that a light ivory be used, of about the same color as that of the U. S. penny postcard. The side walls may be of a slightly darker tint; but in order to avoid contrasts, and also prevent needless absorption of light, dark colors should not be used on the upper side walls of the drafting room.

Two principal types of indirect lighting fixtures are commonly employed for the illumination of drafting rooms. The luminous bowl type unit, as illustrated in Fig. 413, and the opaque indirect unit, as shown in the illustration of Fig. 414. Both are strictly indirect lighting devices. That shown in the first illustration contains a silvered X-Ray reflector, in the bottom of which is a small diffusing cup which serves to illuminate the outer glass bowl of the luminaire. In other words, the lighting mechanism in both cases is practically identical. The results obtained on the drafting table are of the same diffuse and agreeable quality. Fundamentally, the only difference is in the appearance of the fixture. Some users prefer the luminous style and others the opaque.

For the American Can Company drafting room, illustrated in Fig. 413, the room is divided architecturally into bays about 16½ feet square. Four of the luminous indirect lighting fixtures are suspended from the ceiling in each bay, and each is equipped with a 300-watt lamp. The intensity of illumination that results from this arrangement is of high value and extremely satisfactory for the important work that is accomplished in this room.

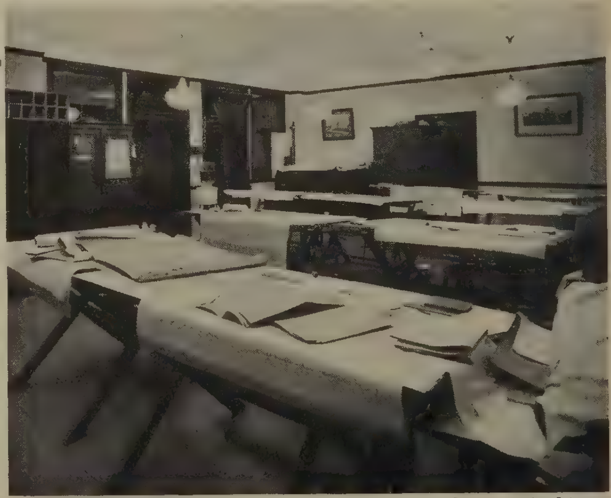


FIGURE 415—Drafting room of Mr. P. H. Johnson, Architect, Philadelphia, Pennsylvania. With proper intensity of light the reading of blue prints is not fatiguing to the eye.

In practically all cases the fixtures in the drafting room employ a single lamp of large wattage. From the information supplied by the lamp manufacturers, we find that the large lamps are more efficient, as far as their delivery of light is concerned, than the smaller sizes in proportion to the amount of wattage consumed. In other words, watt for watt, the large lamps give a greater number of lumens than the smaller lamps. For greatest efficiency, therefore, a large lamp should be employed in drafting room lighting. The fixtures as illustrated in Figs. 414 and 417 are designed for use with a single lamp, ranging in size from 300 watt to a maximum of 1500 watt capacity. Installations are now being made in many drafting rooms using 750 watt or 1000 watt lamps spaced 16 feet apart. This arrangement results in the high intensity of lighting necessary for the speedy and accurate work to be done in the drafting room.

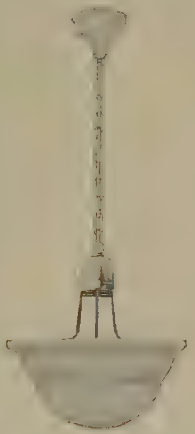


FIGURE 416—A luminaire manufactured by Curtis Lighting especially appropriate for illumination in drafting rooms.

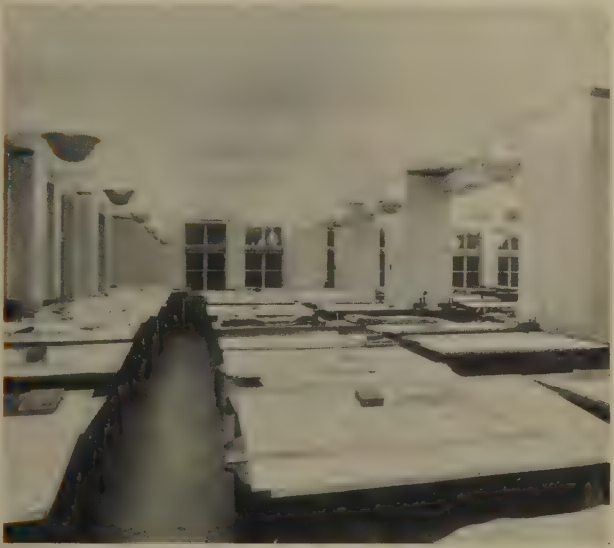


FIGURE 417—Drafting department of the Pacific Gas and Electric Company, San Francisco, California. The drop cord and goose neck lamp for the draftsman disappeared with the adoption of indirect lighting.

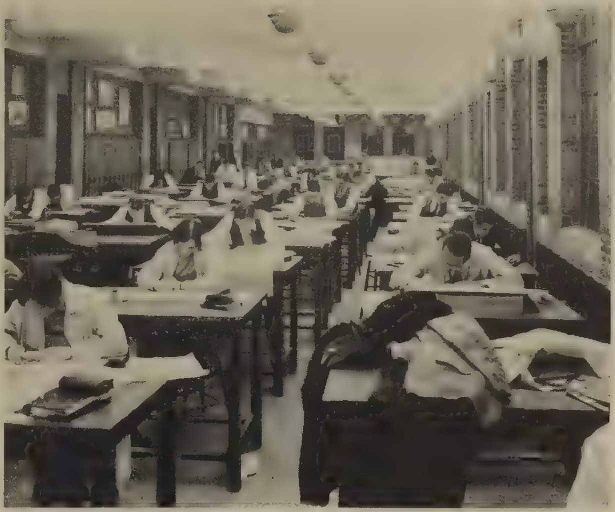


FIGURE 418—Drafting room in the Architectural Building, University of Michigan, Ann Arbor, Michigan. Emil Lorch and Associates, Architects. Note unusual arrangement of lighting units to get daylight direction.

Those in charge of drafting rooms frequently desire to imitate as nearly as possible the daylight direction, and insist on placing the lighting units in such a manner that the predominant amount of illumination comes from practically the same direction as from the windows during daylight.

In the example shown in Fig. 418 one row of fixtures is located very near the windows. This scheme was adopted for the architectural department of the University of Michigan after several months of experimenting to determine not only the best method and type of unit, but also the proper location for the hanging of the fixtures for the particular work carried on by the students of that university. It will be noted that the outer wall of the room is made up entirely of window area for best daylighting. It was desired to have the predominant direction of the artificial lighting the same as for the daylight, hence the fixtures were offset from the usual arrangement.

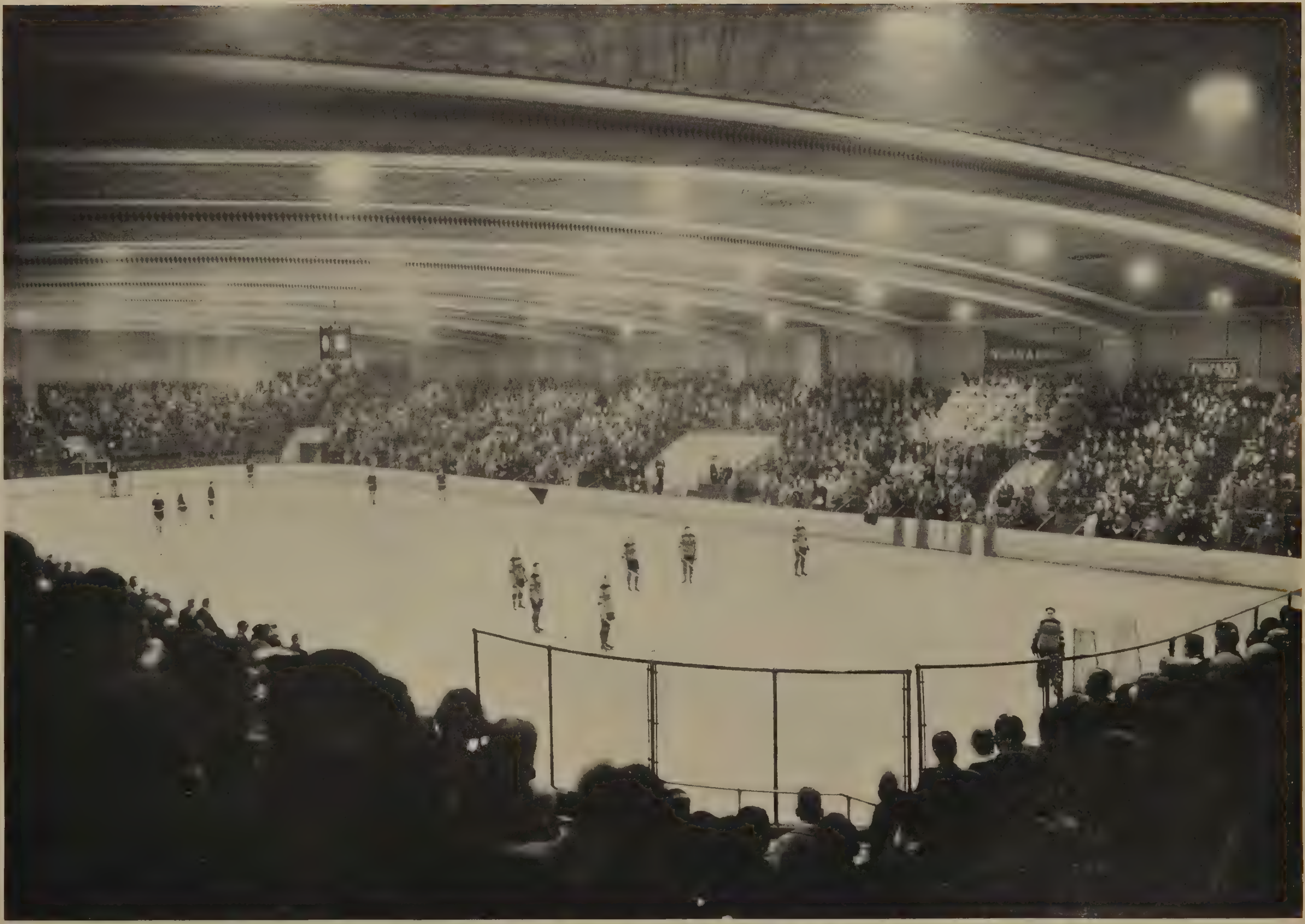
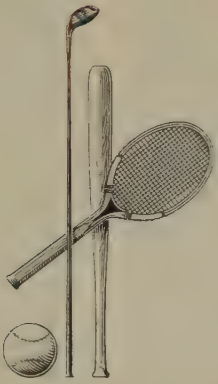


FIGURE 419—The hockey rink in the Coliseum Building, Tulsa, Okla. Smith and Center, Architects, Dallas, Texas. The "Big Boy" X-Ray reflector is recessed above the ceiling line and concentrates its rays upon the playing floor.



SPORTS AND RECREATION

THE average individual of today spends about one-fourth of his time in play and recreation. It is no wonder then that we are considering the importance of play more seriously than ever before. We think of it not as an indulgence but as the natural birthright of man, woman and child. It is play that balances work. It better prepares and keeps us fit for work. It is the big and important health giving activity that is necessary to our material and physical well being. Pleasure, honor and victory are its by-products. Play today is highly organized. It has an important place in our general education. Clubs and associations are formed to plan, to properly supervise and generally spread the gospel of play.

Light has enlarged the world of play, has extended the hours for recreation. Darkness is no longer a limitation upon the activities of our play life. Ours is an age of night sports and pleasures depending very largely upon the radiance from artificial lighting sources. Good play and likewise good lighting is subject to rules. Poor lighting like poor play drugs the intelligence and produces an unhealthful fatigue. Good lighting is stimulating and makes for alertness in play. The lame man in the race has less chance than his able-bodied fellows. Uncontrolled light will handicap any contestant and spoil an evening of entertainment and recreation for thousands of spectators.

Each class and type in an extensive list of indoor and outdoor sports presents a distinct problem in illumination. Practice in gymnasium lighting cannot, for example, logically be applied to the illumination of a boxing ring; while the dance hall and the bowling alley are widely separated in their lighting requirements. It is obviously impossible to show examples for all kinds of recreational activities, hence only a few typical classes have been selected to illustrate modern practice in lighting, supplemented on Pages 293 and 294 by a detailed discussion of the technical requirements for various sports, and with suggestions regarding the most suitable lighting equipment.

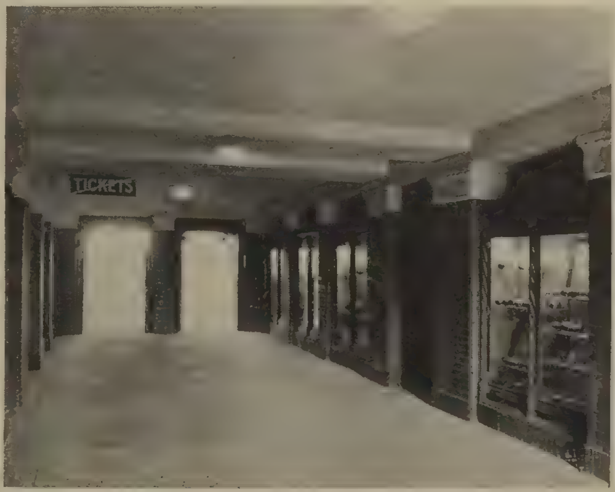


FIGURE 420—Lobby of the Yost field house, University of Michigan, Ann, Arbor. General lighting is provided, and special illumination in the trophy cases.

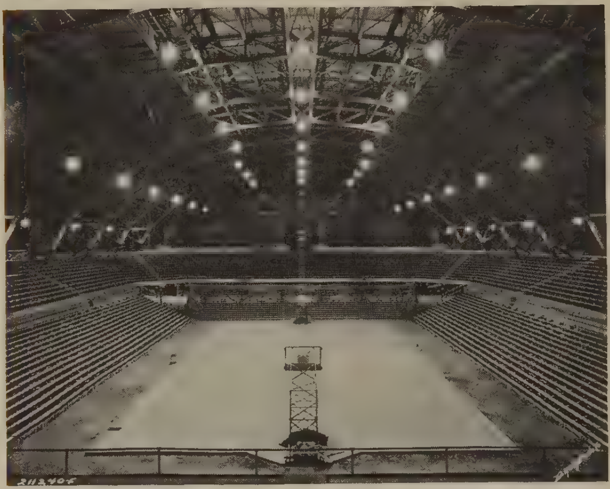


FIGURE 421—Field house, Butler University, Indianapolis, Ind. Harry P. Bartlett, Architect.

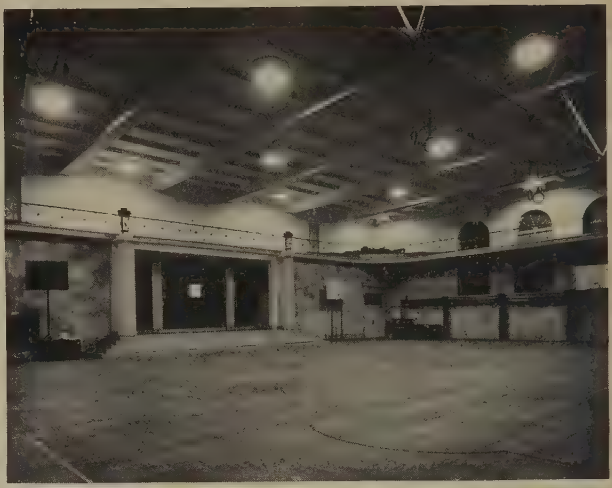


FIGURE 424—Gymnasium of Barnard College, New York, N. Y. Reflectors are cased in ornamental housing.

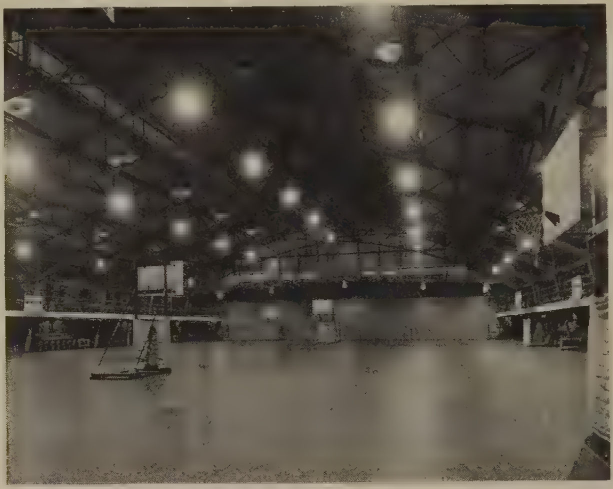


FIGURE 422—Fordham University gymnasium, New York, N. Y. The reflectors are protected by wire guards.

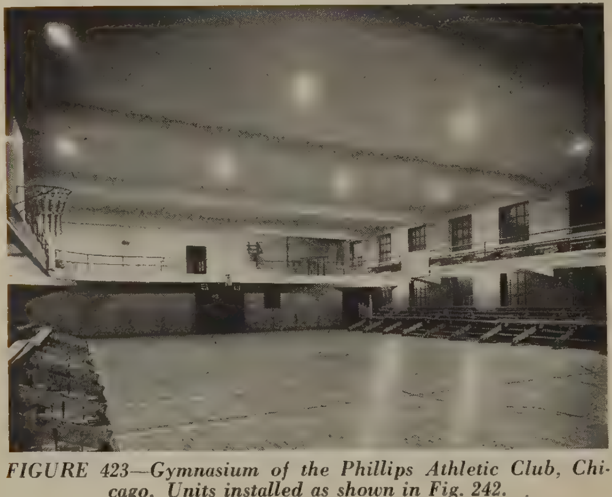


FIGURE 423—Gymnasium of the Phillips Athletic Club, Chicago. Units installed as shown in Fig. 242.

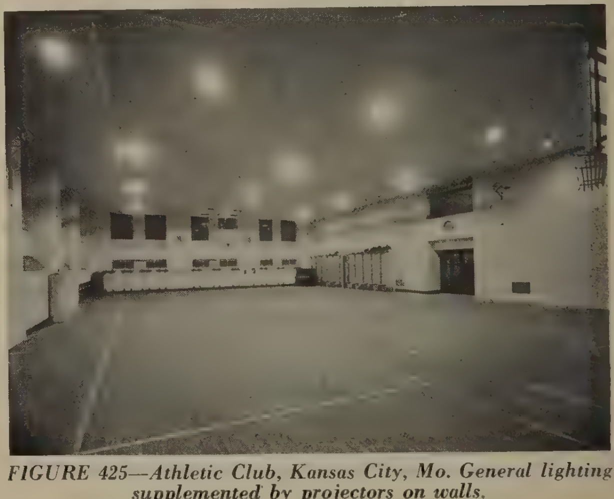


FIGURE 425—Athletic Club, Kansas City, Mo. General lighting supplemented by projectors on walls.

Gymnasiums

There is no place where the importance of good lighting is more obvious than in the gymnasium. Players of strenuous sports must rely on the accuracy of their eyesight as well as on the strength and agility of their limbs. Indoor tennis, handball, baseball, and many other games require keen and uninterrupted vision.

The field house of Butler University, illustrated in Fig. 421, is interesting from several standpoints. It shows a proper and efficient plan for the illumination of a large structure for indoor sports. The playing area or arena has concentrated upon it a strong lighting from reflectors of the type shown in Fig. 428. For the seating area smaller and more distributing reflectors are employed, giving sufficient illumination for the reading of programs and the general comfort of those attending the games. Five hundred-watt units are sufficient for the audience, while 1500-watt lamps are employed over the playing area. The latter, which hang about 60 feet from the floor, are lowered by special winches for cleaning and renewal of lamps. A floor plan and further descriptive information are given on page 293.

The gymnasium of St. Philips Athletic Club. shown in Fig. 423, is a model of modern construction. It may be noted that the gymnasium floor is not crowded with apparatus, but is clear at all times. Not even steam coils mar the simple beauty of its paneled, decorative brick walls and its white ceiling. There is a sixteen lap track balcony and seating capacity for two thousand spectators.

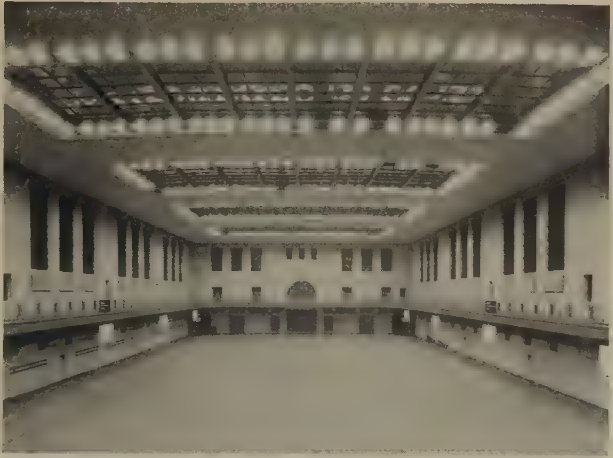


FIGURE 426—Girard College drill hall, Philadelphia, Pa. J. P. Windrum, Architect. Daylight diffusion and directional effect is produced by the equipment installed in the ceiling.

Well placed lighting units, equipped with X-Ray reflectors, are recessed above the ceiling, making wire cage guards or glassware protection unnecessary. This room is 97 feet long, 63 feet wide and has a ceiling height of 20 feet. Under the balcony ceiling hemispheres have been installed to illuminate this space and provide ample head-room.

The Fordham University gymnasium is one of the largest in the country, being 180 feet wide and 225 feet long. This large interior is illustrated in Fig. 422, where a general idea of the lighting equipment may be obtained. Direct lighting reflectors of the type shown in Fig. 429 are utilized. A wire cage affords protection to the reflector and lamp from flying balls and swinging apparatus. All reflectors are installed near the ceiling, well out of the normal range of vision. The player is given adequate lighting for rapid clear seeing.

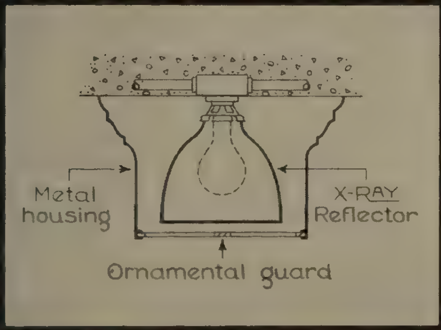


FIGURE 427—Diagram of method of installing reflectors in Barnard College.

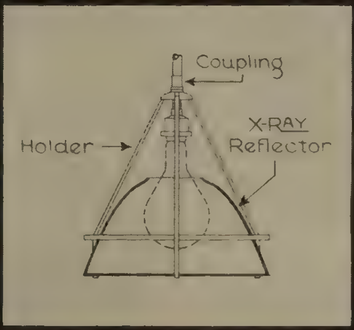


FIGURE 428—Unit used in the Coliseum Building, Tulsa, Oklahoma.

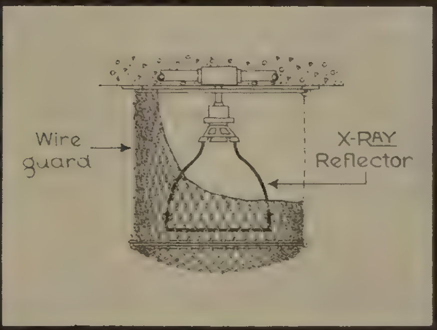


FIGURE 429—X-Ray Reflector for gymnasiums with protecting wire guard.

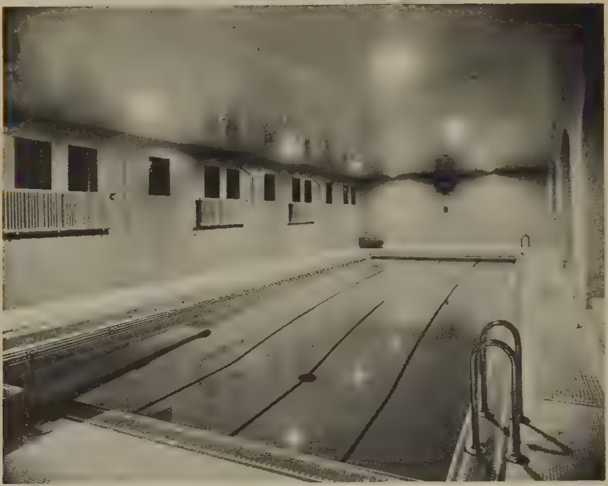


FIGURE 430—Swimming pool of Racquet Club. Chicago. Rebori, Wentworth, Dewey and McCormick, Architects. Units of the flush mounting type are employed.

Very seldom do we find a gymnasium or drill hall as large as that on the campus of Girard College. The size of this immense room is suggestive of the generosity of Mr. Stephen Girard, the founder of the institution, whose legacy to the orphan boys of Philadelphia is doing great honor to his name. The drill hall is well supplied with daylight from large glass ceiling panels. With reflectors arranged around the edges of the huge ceiling openings the directional value of daylight is secured. The high quality of diffusion obtained from direct lighting units properly installed is very effective here. By wiring the lighting units on separate circuits various intensities may be obtained for different types of sports. To obtain an idea of the size of the room, it may be stated that five regulation tennis courts are marked off on the floor. Five basket ball courts are also provided, so that an equal number of games may be in progress simultaneously. The illumination system required an installation of three hundred and twenty No. 580 X-Ray reflectors, each of which is equipped with a 300-watt lamp. The intensity of ilumination received is sufficient for the playing of a fast game of tennis with ease after daylight.

Coliseums

In the coliseum of the ice palace at Tulsa, Oklahoma, a special system of direct lighting, with all reflectors concealed above the ceiling line, was considered by the architect to be the most feasible system for the illumination of this large interior. Lamps of the 750-watt size, burning in the X-Ray "Big Boy" reflector No. 590, are suspended from the concrete roof construction by means of a special hook and ring over panels of glass set into a flange in the ceiling. Sixty-two of these lighting units spaced twenty feet apart are required for the illumination of this large coliseum. The ice sheet, shown in Fig. 419, is approximately 75 by 100 feet, and receives a high intensity of illumination suitable for the fast movements of hockey.

Indoor Swimming Pools

Typical of the modern swimming pool is that shown in Fig. 430, in the Racquet Club of Chicago. It was the desire of the architects to have lighting equipment that would not protrude below the ceiling line, therefore the system illustrated in Fig. 242 was adopted, with all fittings entirely hidden from view.

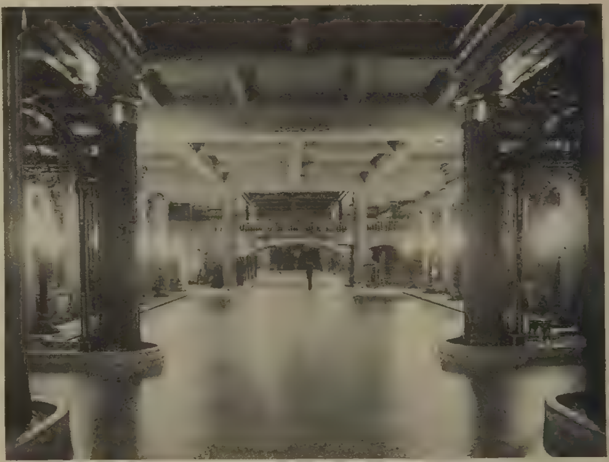


FIGURE 431—Piscine du Lido, Paris, France. The unique swimming pool restaurant of the French metropolis.

The fashionable Piscine du Lido, in Paris, France, the swimming pool restaurant, is an extremely unusual institution, requiring the exercise of ingenuity in its lighting arrangement. It may be noted from the illustration that on both sides of the pool are pedestals which carry inverted X-Ray reflectors, the light from which is diffused by opal glass domes. The effect is very pleasing, resulting in a soft radiance of just the proper intensity. Several floodlights, which do

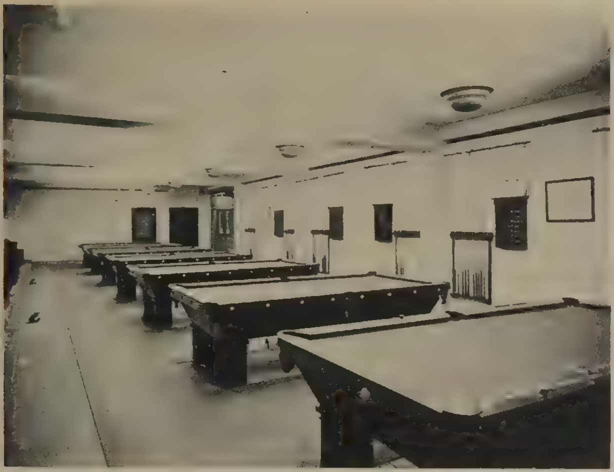


FIGURE 432—*Typical lighting arrangement for pool and billiard tables, using opaque indirect luminaires.*

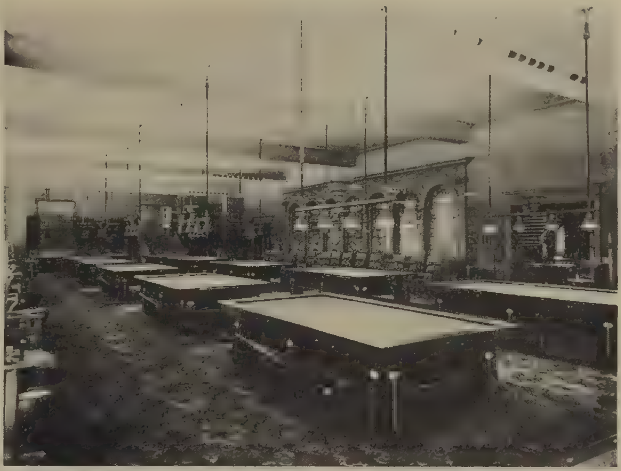


FIGURE 434—*Business Men's Club, Cincinnati, Ohio. Direct and indirect lighting from special fixtures over the tables.*

not appear in the illustration, project light upon the pool, causing a fascinating surface sparkle.

Bowling Alleys

A well lighted bowling alley is illuminated to a moderate intensity spread uniformly over the alley surface without direct or reflected glare and with the pins high lighted to be easily discernible. In the lighting of the new Waukegan Recreation Company's bowling alleys, illustrated in Fig. 433, advantage has been taken of the fact that the ceiling construction included some large beams running across the room. The backs of the beams afforded a very advantageous location for the installation of reflector equipment. The first row is visible just below the edge of the beam, and indicates the position and number of units that have been installed for the illumination of the alleys. It may be noted that these reflectors are of the angle type X-Ray No. 400, as used for show window illumination, and are supplied with 150-watt lamps. The pins are more strongly illuminated than the alley surface as described on page 293.

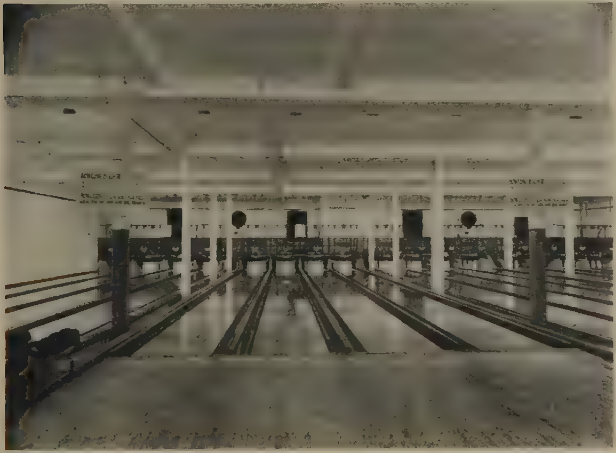


FIGURE 433—*The New Recreation Company, Waukegan, Ill. Reflectors are concealed behind ceiling beams. Special units concentrate light upon the pins.*

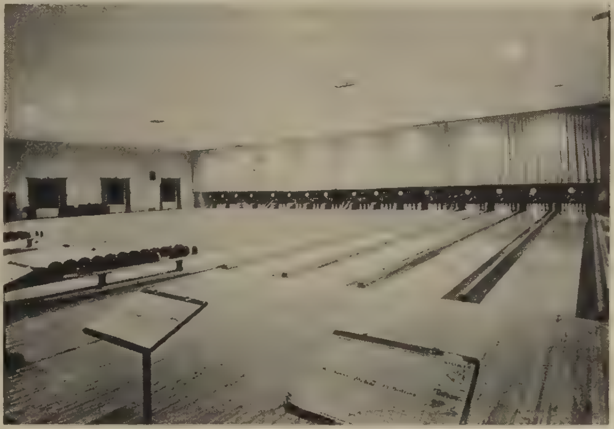


FIGURE 435—*Cocked Hat Bowling Alley, Kansas City, Mo. All lighting equipment recessed in the ceiling arranged to give perfect illumination on the alleys and pins.*

A recreation room of the most modern type is shown in Fig. 435, provided with a particularly well diffused illumination from units that are concealed above the ceiling. Here, again, the light for the pins is of a higher intensity than for the playing floor. The reflectors and lamps for the general lighting are accessible for cleaning and renewals by opening the hinged rim cover glass.

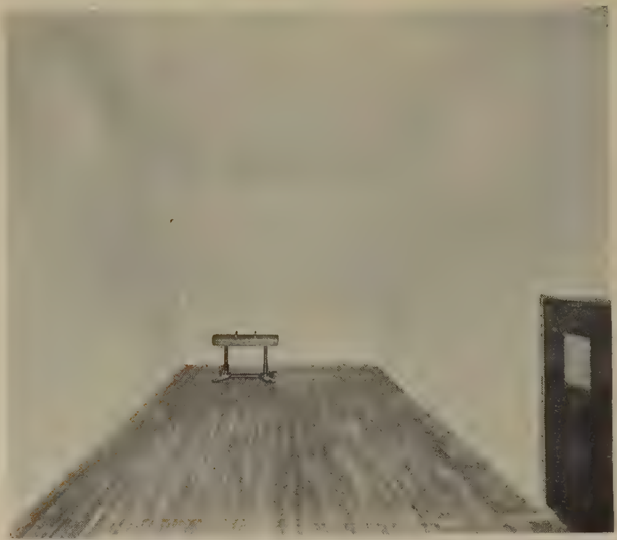


FIGURE 436—Handball court of the William Jewell College, Liberty, Mo. Charles A. Smith, Architect, Kansas City. X-Ray reflectors are recessed in the ceiling, with hinged rims and diffusing glass lens.

Pool and Billiards

Indirect lighting has been found to be particularly suitable for the illumination of pool and billiard rooms. A typical example is shown in Fig. 432, where an indirect lighting fixture is installed over each table, with extremely effective results. Since an indirect fixture gives its highest intensity directly beneath the unit, the arrangement shown is very advantageous, because of the fact that good lighting is obtainable even though all of the lamps in all the luminaires in the room are not burning. Individual switching of luminaires assists in the economy of operation of the institution. Very frequently indirect lighting is used only for the general illumination of the room, and the tables are lighted by strong direct illumination from open reflectors, as is the case in Fig. 434. Here we see a special direct lighting unit suspended from a 15 foot ceiling, one over each table, and using four X-Ray reflectors in spun metal housings supported from a brass tubing or bar, from the center of which projects the indirect lighting fitting. Four 50-watt lamps supply generous illumination for the table, while a 300-watt incandescent lamp in each fixture is sufficient for the illumination of the room.

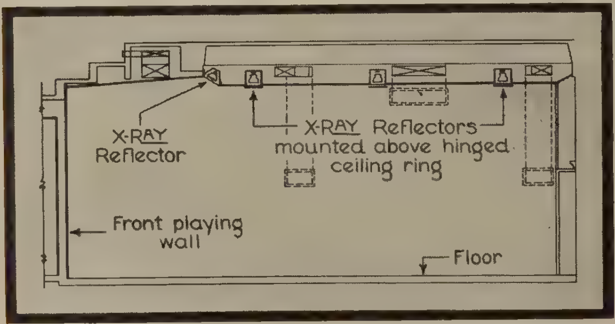


FIGURE 437—Sectional diagram for ideal lighting layout of squash court.

Handball and Squash

Practically all athletic clubs and many gymnasiums are equipped with standard handball courts which measure about 18 by 40 feet in dimensions, with a ceiling height varying from 10 to 20 feet. Typical of this class of playroom is the court of the Brown gymnasium at Liberty, Missouri, shown in Fig. 436. Here a very simple, economical and effective arrangement has been installed, utilizing only eight lighting units. Those that appear in the photograph near the end wall

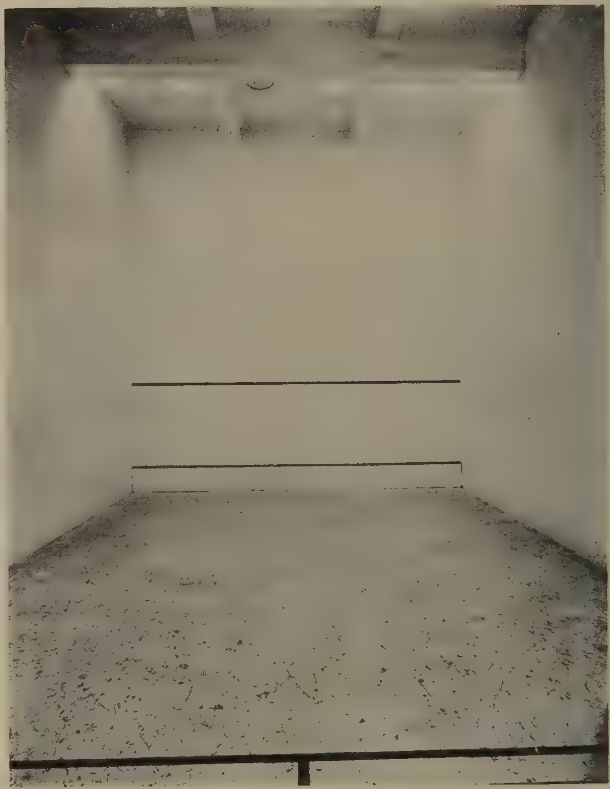


FIGURE 438—Handball court in the Penn Athletic Club, Philadelphia. W. V. Pangborne & Company, Architects.

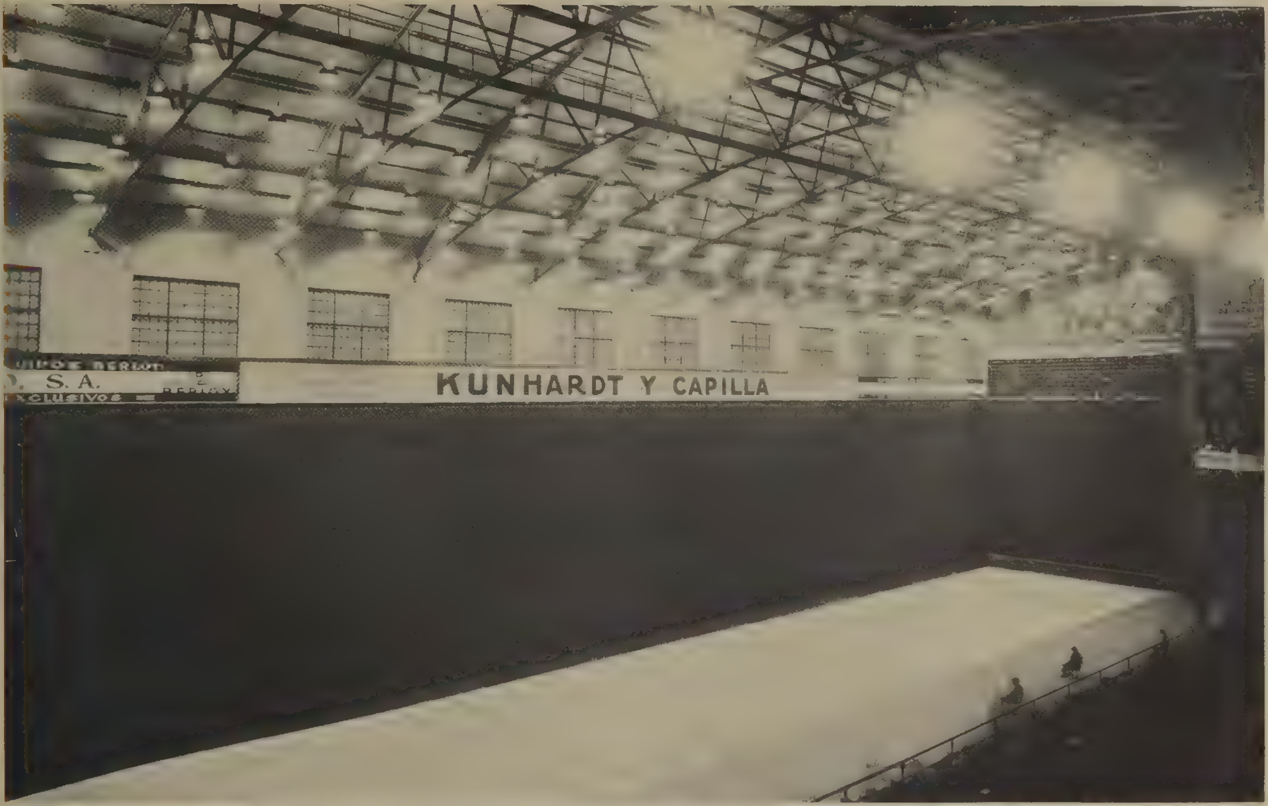


FIGURE 439—Jai Alai court, Fronton, Mexico City, Mexico. An illumination of 50 foot-candles is produced by the proper arrangement of X-Ray "Big Boy" reflectors.

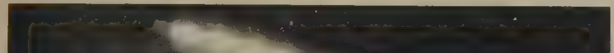


FIGURE 440—Racquet court of the Racquet Club, Chicago. Rebori, Wentworth, Dewey and McCormick, Architects.

are reflectors for 200-watt lamps embedded in the ceiling in a metal box with a hinged rim or cover, having a 10 inch diameter diffusing glass lens. A similar arrangement is installed at the other end of the room, while the central portion of the space is illuminated by two reflectors of a larger diameter for 300-watt lamps similarly installed with 14 inch diameter hinged ceiling rims and glass lenses. This arrangement is usually effective and is entirely satisfactory for the type of play for which the room is used. A similar scheme can be used for squash court lighting. Squash is a game requiring great accuracy in placing the ball. The end wall, to which the ball is directed, must have a high level of illumination.

Racquets

The racquet courts of the Racquet Club in Chicago are illuminated by a system of overhead strip lights similar to those used for borders on a stage. The relative location of the equipment is indi-

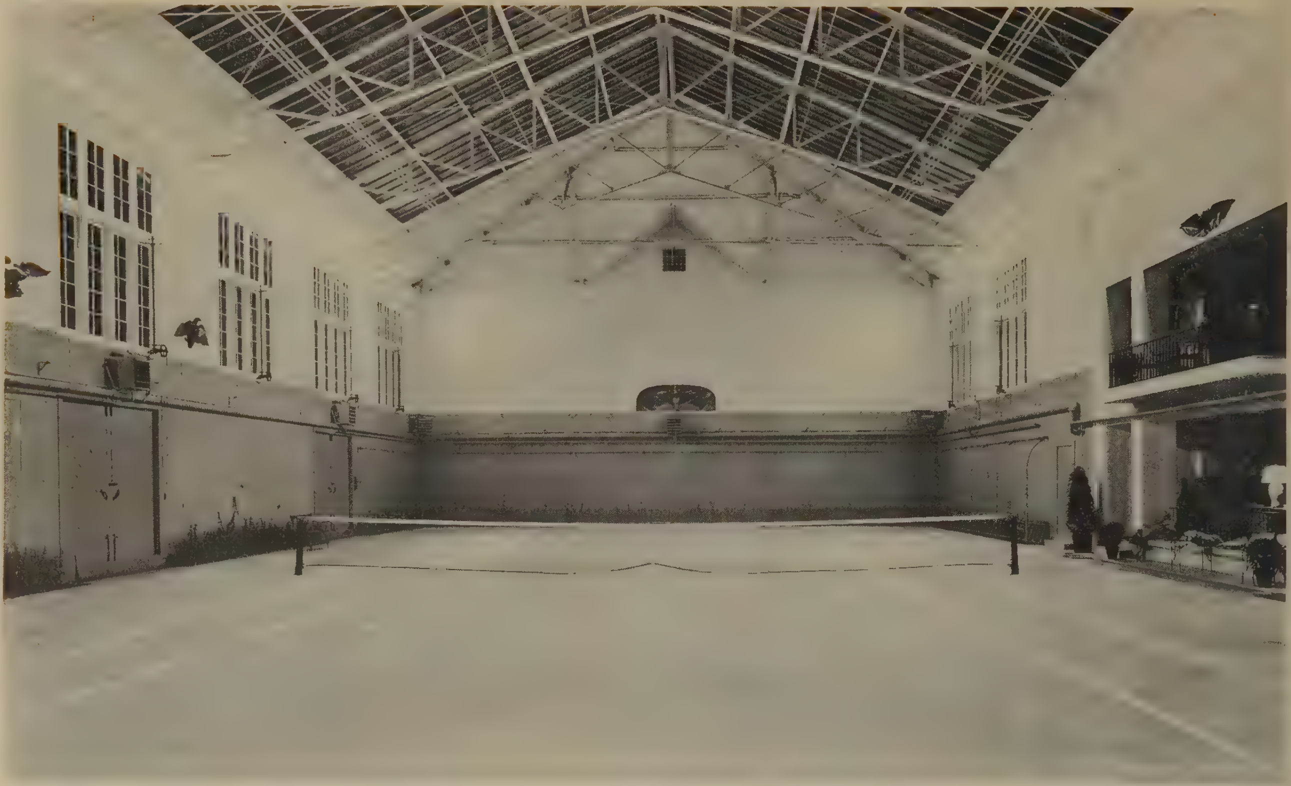


FIGURE 441—The private tennis court of the donor of the Davis Cup, St. Louis, Mo., employing an unusual and most effective lighting method, a detail of which is shown in Fig. 445.

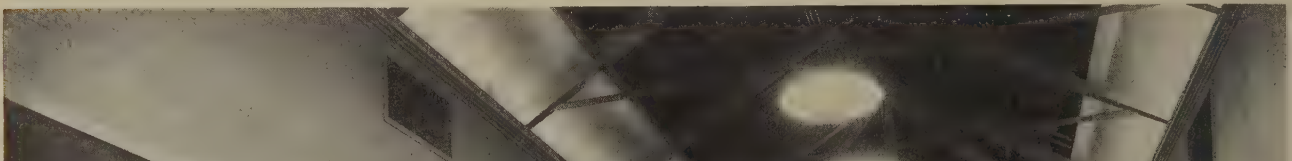


FIGURE 442—Court tennis court of the Racquet Club, Chicago. Rebori, Wentworth, Dewey and McCormick, Architects. Indirect lighting from coves and special luminaires produce the desired illumination.

cated by the illustration in Fig. 440. Three rows of border type lights are suspended from the underside of the roof trusses in such a manner that the entire lighting equipment can be lowered to the floor for cleaning and renewal of the lamps. Steel cables, passing over pulleys, lead back to the rear of the room, where by means of a crank the lowering and raising process is accomplished. Each lighting trough is 24 feet long and contains an equal number of X-Ray reflectors for 200-watt lamps. A wire screen over the opening of the housing protects the equipment from damage.

Jai Alai

One of the speediest of all games and, therefore, one that requires the ultimate in perfect lighting is that of Jai Alai. The Fronton in Mexico City adopted the X-Ray No. 590 reflector for its illumination because of the fact that this reflector concentrates a maximum of the light directly downward on to the playing floor and walls, with practically no reflected glare into angles at which the players would customarily view the unit. The playing court is about 220 feet long by 38 feet wide, with a wall about 40 feet high at the two ends and on one side. For better vision the front wall is painted black and the others light blue.

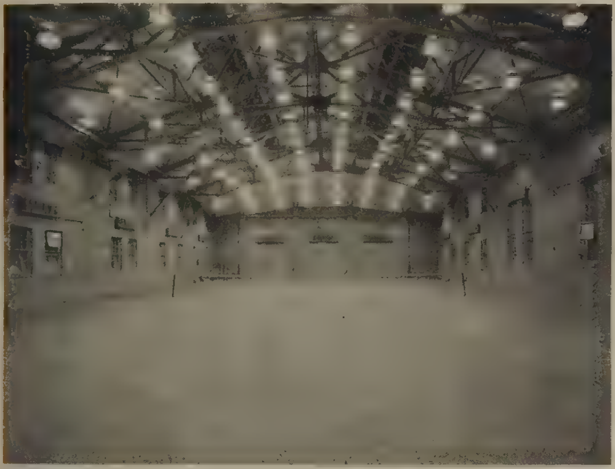


FIGURE 443—Indoor tennis court, Penn Athletic Club, Philadelphia, Pa. W. H. Pangborne & Company, Architects. Direct lighting reflectors, closely spaced, produce intense and comfortable lighting.

Because of the great speed at which a ball travels an extremely high intensity of light is required, perhaps higher than for any other game. High lighting values decrease the time required for perception and thus assist the player in following the ball to play it and to avoid being hit. When planning the particular installation pictured, the likes and dislikes of individual players were obtained by interview. It was found that the players did not favor floodlighting, lighting from the sides or from angle type reflectors. Therefore, it remained to install the overhead system of direct lighting. The complete layout consists of 88 No. 590 reflectors, each of which is equipped with a 1000-watt lamp, protected by a wire guard and mounted 45 feet above the floor.

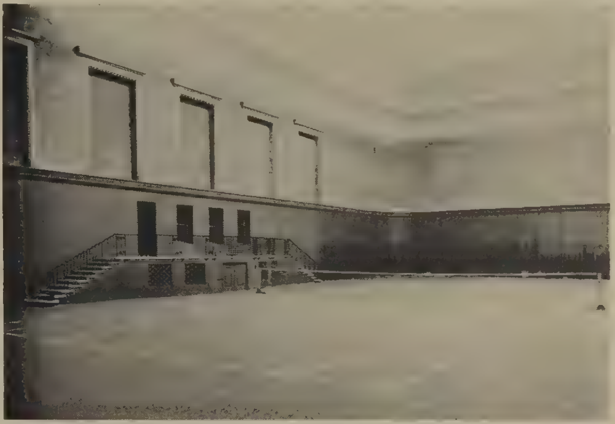


FIGURE 444—Private tennis court on a Long Island estate, with special illumination, combining both direct and indirect from a high ceiling.

Indoor Tennis

An unusual type of court, known as the court tennis court, is illustrated in Fig. 442. The general scheme of lighting includes two types of

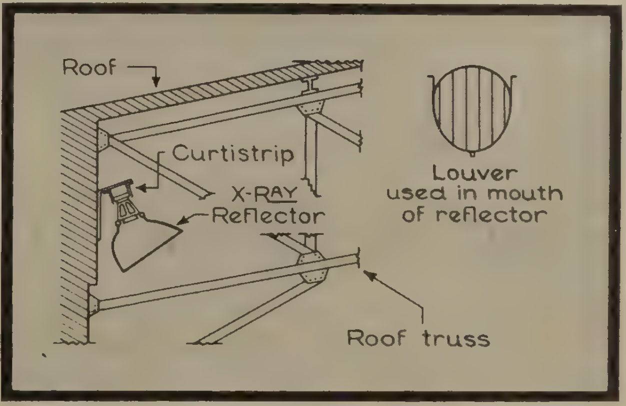


FIGURE 445—Diagram showing special lighting method used for the illumination of the Davis tennis court.

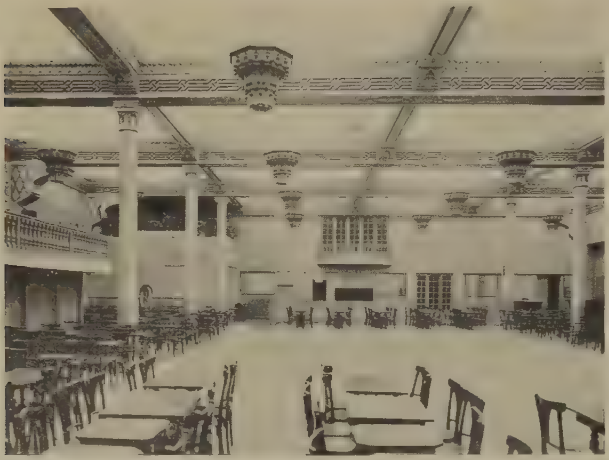


FIGURE 446—Magic City Dance Hall, Paris, France. Mr. P. Fenarv, Architect. Luminaires incorporate three distinct systems of lighting for special effects.

equipment. One system consists of a number of specially designed fixtures suspended from the trusses. This unit, because of the construction of the ceiling, carries its own reflecting surface, which is in the form of a curved umbrella canopy 6 feet in diameter, and below which is suspended an X-Ray indirect lighting reflector bowl, designed to accommodate a 1500-watt lamp. Supplementing the luminaires just described, there is a system of cove lighting around the four sides of the room, with units located in the lighting trough hollowed out in the side wall, at a point where the roof trusses terminate.

Championship games of tennis have been played in the room illustrated in Fig. 443, the indoor court of the Penn Athletic Club in Philadelphia. A carefully planned system of lighting, using one hundred X-Ray reflectors of capacity for 500-watt lamps, provides a strong but well diffused illumination throughout the entire room. Close spacing of reflectors is necessary as it is desirable that the entire atmosphere be filled with light, so that the ball is well illuminated at any position of its flight. It may be noted also that the light that escapes from the neck of the reflector and through the shade holding device is just sufficient to produce a proper sky effect to give a light background against which the ball is easily and comfortably seen. The reflectors, which are of an angle type, project their light towards the net, and are equipped with wire guards and louvers which protect the equipment and prevent a view of the brilliant lamp when the players look upward.

Practically all the qualities desirable in the lighting of an indoor tennis court are to be found in the room illustrated in Fig. 441, the private court of Mr. Samuel Davis, of St. Louis. This is an outstanding example of indoor recreational building housing the tennis court, lounge and gallery. The interior dimensions of the court building are 64 feet in width by 126 feet long, thus leaving a space of 18 feet at each end and 14 feet on each side to afford freedom of movement.

It has been seen in previous chapters how the intensity of illumination affects the speed of vision. In the playing of tennis a ball passing from an area of high intensity to one of lower degree appears to gather speed and conversely when it passes from a low intensity to a higher one it seems to slow down. Such variations in lighting intensity were avoided as they would tend to render the court useless for night-time championship tennis, hence excellent illumination is provided.

Uniformly distributed illumination averaging 32 foot-candles is accomplished by the use of 132 X-Ray reflectors equipped with 200-watt lamps, mounted 25 feet above the floor on permanent brackets. Glare in the players' eyes from this lighting equipment is minimized by the use of louvers, like those illustrated on Page 300.

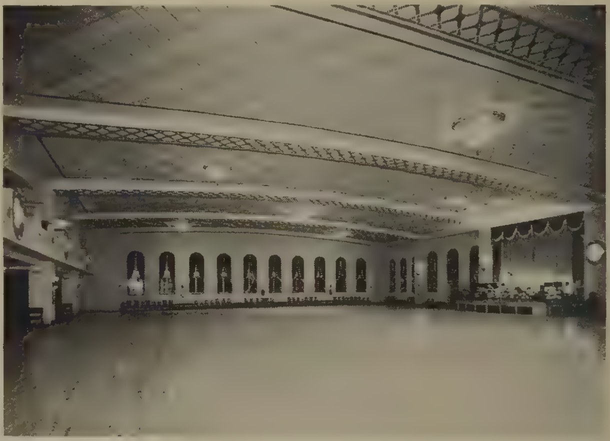


FIGURE 447—Pla-Mor ballroom, Kansas City, Mo. Charles A. Smith, and George E. McIntyre, Architects. Beautiful effects are produced by constantly changing color lighting.

For the private tennis court of Fig. 444 a combination of direct and indirect lighting has been adopted. The indirect lighting units suspended at the ceiling are noticeable in the illustration. On the opposite side of the room direct lighting reflectors are embedded flush with the ceiling, and concentrate their light upon the court. The shadows cast by the direct lighting source are softened by the indirect illumination from the opposite side. The system is very effective in producing a directional effect to the light, similar to that received during the daytime.

Dance Halls

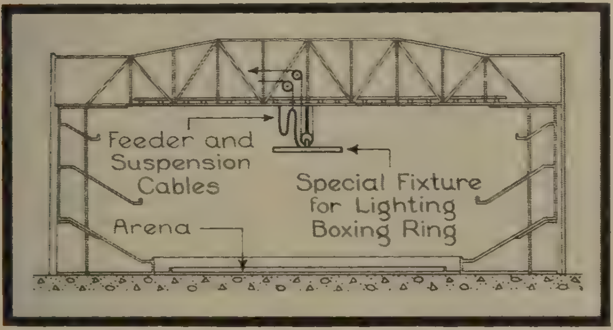


FIGURE 448—Diagram showing the location of boxing ring lighting unit for the Coliseum in Boston, Mass.

Probably the most popular of our indoor forms of recreations is that of dancing. Light is one of the most subtle means of producing striking effects in interiors of this character. The Magic City Dance Hall in Paris, France, shown in Fig. 446, has three distinct systems of lighting, all incorporated in the one luminaire designed to harmonize with the interior decorative scheme. A direct lighting effect may be obtained through the bottom of the fixture with an amber tinted light. Indirect illumination is also obtainable, as is indicated by the illustration, with lights on circuits that permit of variety in the amount of illumination obtained. A further variation is obtained by auxiliary lamps on the exterior of the lighting unit, thus giving the management an extreme amount of flexibility in illuminating the room.

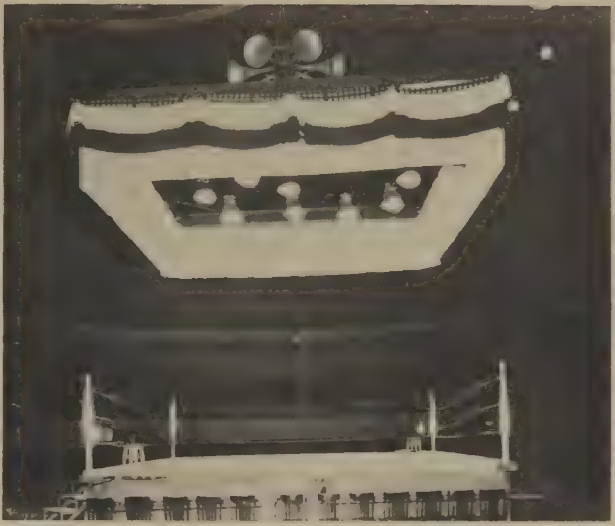


FIGURE 449—The boxing ring of the Olympic Sports Arena. Detroit, Mich. C. Howard Crane, Architect. The special lighting frame is lowered for action.

In the Pla-Mor ballroom, of Kansas City, Mo., color lighting effects are also provided. Designed to accommodate 3000 dancers at one time, this is one of the largest and most beautiful ballrooms in the Middle West, and is illuminated throughout with crystal fixtures. The everchanging colored lighting is one of the entertainment features, made possible by the use of X-Ray reflectors concealed within the many crystal baskets. The electrical circuits are arranged so that the colors may be changed at the will of the orchestra leader, who merely presses a button to secure the desired changes. It may be noted that special lighting for the orchestra is provided by placing concentrating reflectors in the ceiling above the orchestra.

It is in rooms of this character that the Lumitone, described on page 56. is particularly advantageous. The automatic control makes it unnecessary to have an operator to attend the lights. The beautiful combinations that are possible by Lumi-

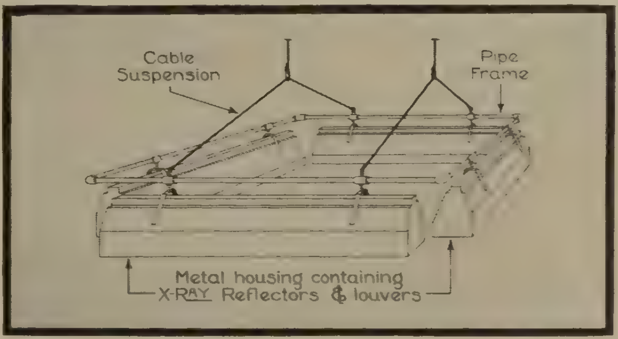


FIGURE 450—Diagram showing the proper construction of a lighting equipment for a boxing ring.

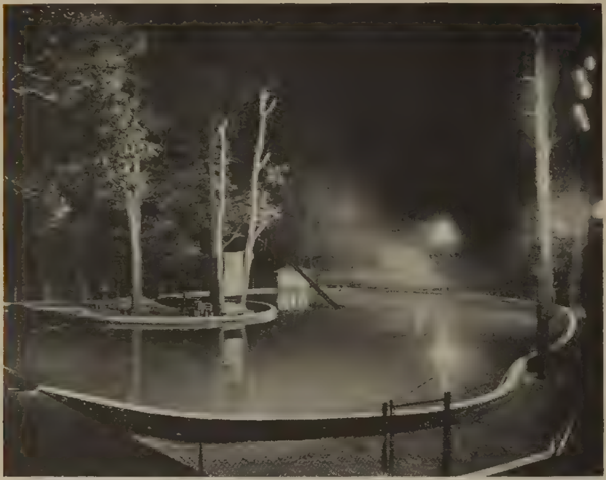


FIGURE 451—Northern Beach Park swimming pool, Indianapolis, Ind. Flood lighting projectors, properly mounted, produce even lighting for the pool.

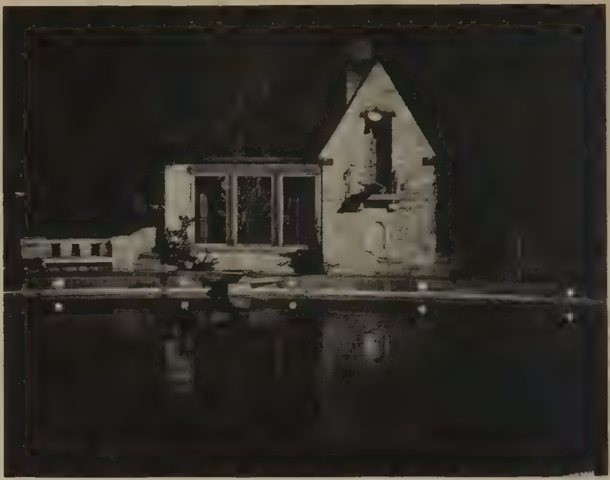


FIGURE 452—Swimming pool of Mr. Fred Wolferman, Kansas City. Boillot and Lauck, Architects. Color lighting effects are produced by equipment recessed in the curb of the pool.

tone control can not be obtained even by the most expert manual manipulations of an operator.

Boxing

A sport that requires unusually effective illumination is that of boxing, hence the Boston Coliseum has provided for its boxing ring an intensity of 400 foot-candles to enable the spectator to clearly follow quick movements and the rapid exchanges of the contestants. Furthermore, it enables motion pictures to be made without special apparatus. The boxing ring unit is of special design, consisting of a frame about 26 feet square, made up of sections of conduit and equipped with eighty X-Ray reflectors for 500-watt lamps. A metal shield placed around the framework conceals the reflectors from view, and the reflectors themselves are equipped with louvers to prevent a direct view of the lamp and eliminate the possibility of glare. The unit when in use is located twenty feet above the floor of the ring, suspended from the roof trusses by wire cables, and may be raised or lowered with a 5 h. p. motor.

An installation of similar character is shown in Fig. 449, the Olympia Sports Arena, in Detroit, Michigan, for which an intensity of 250 foot-candles is provided. Reflectors are installed in an 18-gauge sheet metal housing, the details of which are shown in Fig. 450. In addition to the louvers that form a part of the housing, a curtain or valance is provided to prevent any reflections that might be objectionable to the audience. The general lighting of the area is accomplished by more than one hundred X-Ray reflectors of large size, designed to accommodate 1500-watt lamps, and spaced about 26 feet apart.

Outdoor Swimming Pools

The private swimming pool of Mr. Fred Wolferman, of Kansas City, is particularly interesting because of the manner in which light has been used to produce special effects. The floodlighting of the bathhouse is accomplished by placing amber tinted floodlights in the trees. Although the

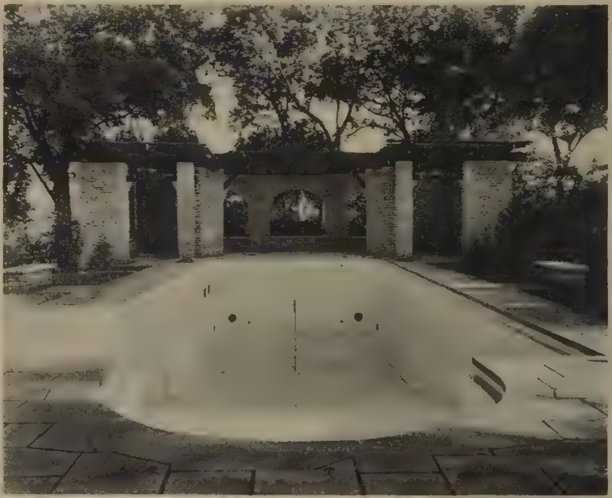


FIGURE 453—Private swimming pool of Grover Hubbell, Des Moines, Iowa. Tinsley and McBroom, Architects. This daylight view indicates the location of under-water lighting units.

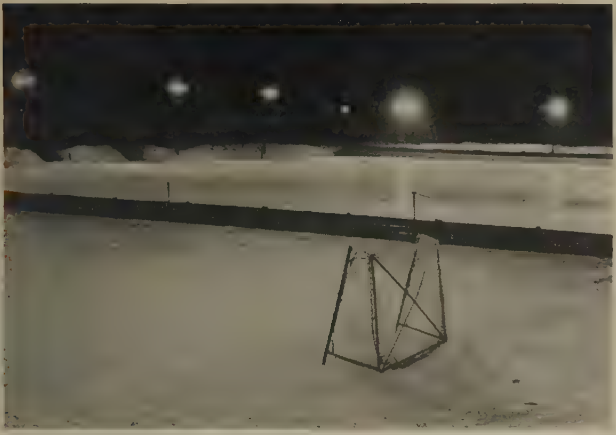


FIGURE 454—East Side Skating Rink, Providence, R. I. Flood lighting Projectors are mounted on poles surrounding the rink.

maximum amount of light is concentrated upon the surface of the building, the stray or spill light falls upon the pool, softly illuminating it. As a special feature, recessed lights are hidden in the curb of the pool near the bathhouse, and equipped with blue-green lenses, which project a tinted sheet of light over the surface of the water with a particularly striking result.

Some very successful attempts have been made to illuminate swimming pools by underwater lighting compartments concealed in the wall of the pool, directing the light into the water. The illustration in Fig. 453 shows a view of the private pool of Mr. Hubbell after the water had been drained. The locations of the underwater units are clearly indicated in the photograph. The illumination of the water by this means adds considerable interest and variety to the aquatic sports of swimming, diving and water polo. The water is given an appearance of green freshness that it does not have under ordinary conditions. The light rays also indicate at a glance any material that may be in suspension or any deposits on the walls and floor. In installations of this character the equipment must be waterproof, and easily reached for maintenance. The most desirable method is to install a permanent heavy glass window in the surface of the pool wall, behind which in a small compartment is concealed the lighting equipment accessible through a small door.

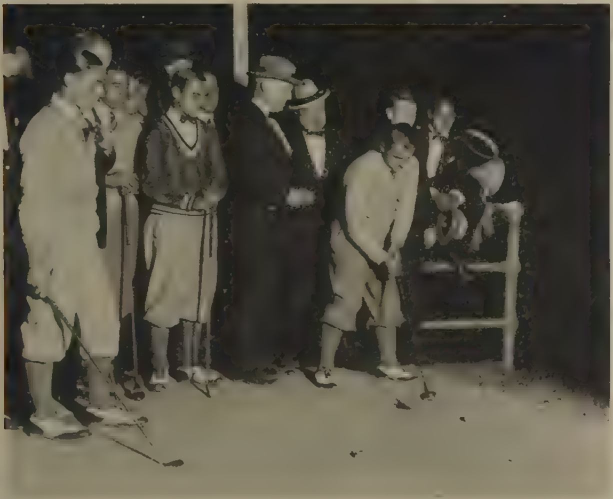


FIGURE 455—Gene Sarazen, professional, driving from the first tee at Briarcliff Lodge, New York, playing with the first "night golf" foursome.

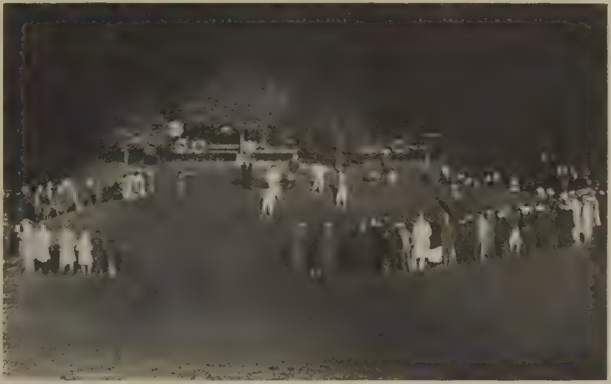


FIGURE 456—The first green at Briarcliff Lodge, illuminated for night playing. Gene Sarazen and companions on the green.

Night Golf

During a convention of the Illuminating Society at Briarcliff Lodge the first fairway of the golf course was illuminated as a special feature. The illustration in Fig. 455 shows Gene Sarazen, who was then professional at the Lodge, driving from the first tee. Ten thousand people watched this performance. Mr. Sarazen with his team mates formed the first "night golf" foursome ever to play in this country. This experiment demonstrated the feasibility of night lighting for golf courses. X-Ray floodlighting projector equipment was used in the demonstration. Since this experiment was made at Briarcliff Lodge many driving practice courses and numerous putting greens have been illuminated for night play.

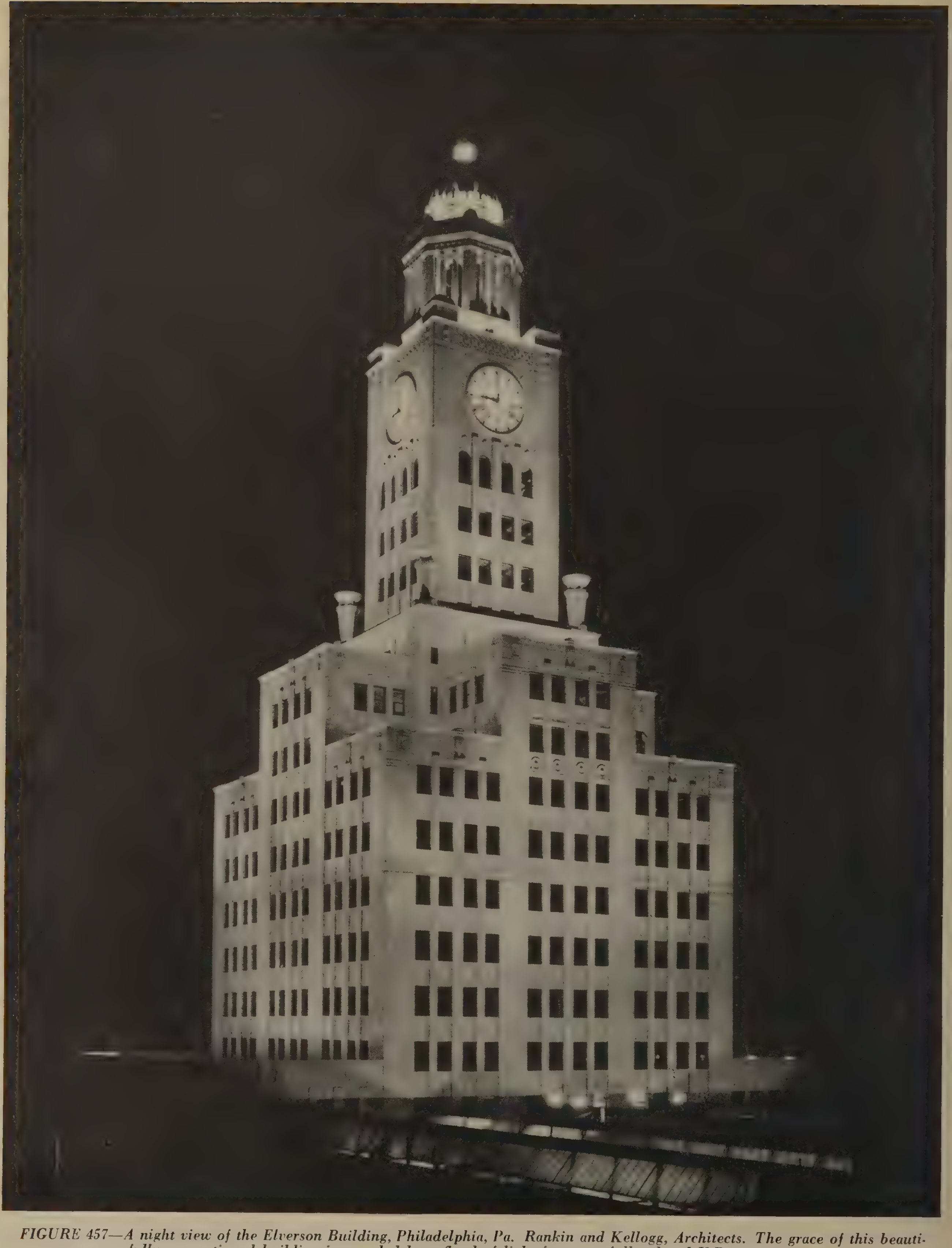
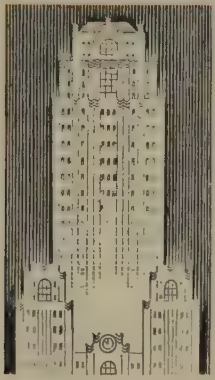


FIGURE 457—A night view of the Elverson Building, Philadelphia, Pa. Rankin and Kellogg, Architects. The grace of this beautifully proportioned building is revealed by a flood of light from carefully placed X-Ray projectors.



FLOODLIGHTING

SOME day, it is hoped, the effects produced by light will have the same artistic appeal as those of music, the drama, and the spoken or written word. The public is rapidly developing an appreciation for the advantages and possibilities in the use of light. Floodlighting has much to do in promoting this attitude. Although one of the newest applications, it has long since passed the experimental stage and is recognized as an important and permanent means of producing many desirable effects. Floodlighting supplements the older forms of display illumination and lends itself particularly to the fields of sculpture, monumental public buildings, and commercial structures, for the illumination of pageants, outdoor sports, to the yards of industrial plants and projects involving night construction.

Floodlighting is one of the most emphatic advertising mediums. It establishes the location of a structure much more convincingly than the street designation. Architects are incorporating in the designs of buildings construction that provides for the effective use of light as a means of architectural embellishment, thus insuring a scheme of lighting that will not be an afterthought.

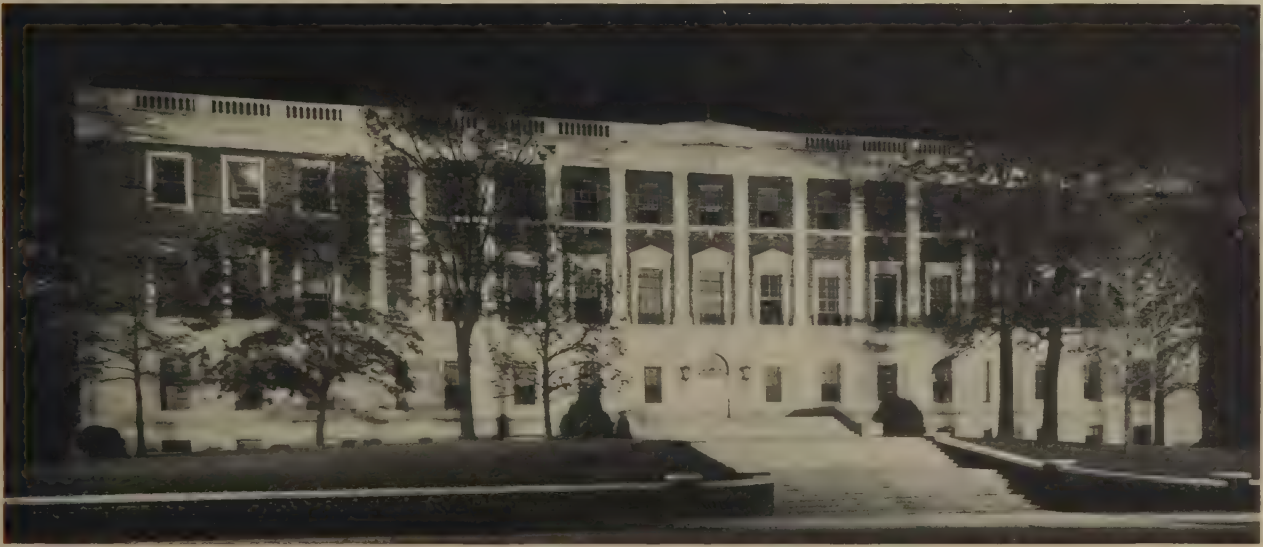


FIGURE 458—The City Hall of Winston-Salem, N. C. Northrup and O'Brien, Architects. The entire front elevation of this important civic building "stands out" in all its formal dignity after daylight hours.

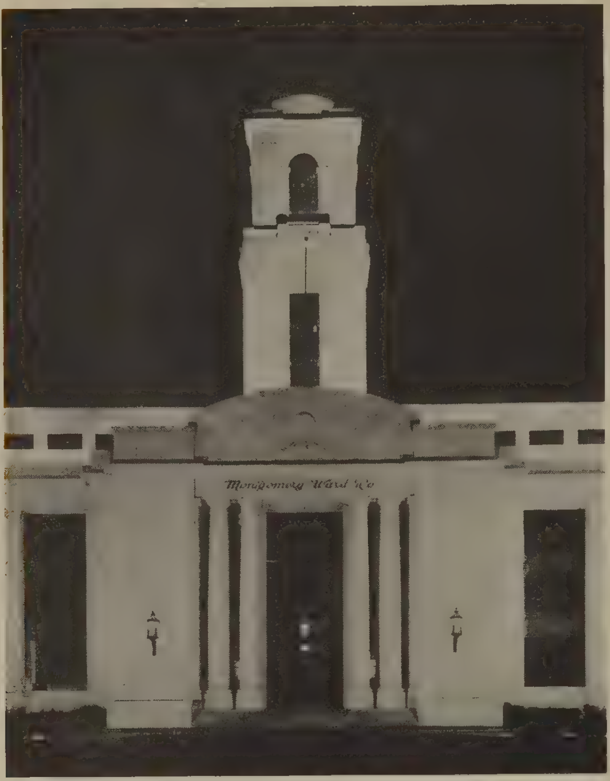


FIGURE 459—The establishment of Montgomery Ward & Company, in St. Paul, Minn., is plainly visible at long distances by the illumination produced by one hundred and sixty X-Ray projectors.

To be successful the intensity of light on building must be greater than for the surroundings. The building surface should be of comparatively light color, as the darker shades absorb most of the light that is directed upon them. The floodlighting units should be as completely concealed from view as possible, mounted so that they are accessible for maintenance. Care should be exercised in the use of color for all applications.

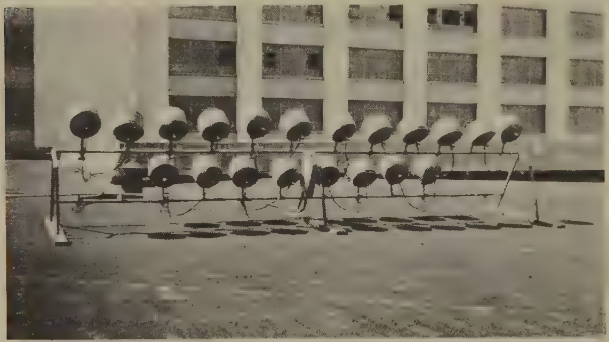


FIGURE 460—A typical method of installing X-Ray projectors on the roof of the Montgomery Ward Building.

The amount of wattage required for floodlighting equipment is something to be determined only after careful study. Varying from a watt per square foot for a surface light in color to seven or eight watts per square foot if the surface is dark. The percentage of light is small that is reflected to the eye from a building illuminated at night, due to the fact that the surface returns only a portion of the light that falls upon it. The remainder is absorbed or reflected at angles out of the eye's range. The reflection value of the exterior surface of a building or other floodlighted object may be as high as 80% and as low as 5%.

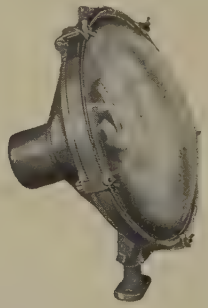


FIGURE 461—Typical X-Ray floodlighting projector. See Page 307 for other equipment for outdoor night lighting.

Equipment now available makes it possible to control the light with a great degree of accuracy. On Page 307 is shown apparatus for concentrated beams or spread beams, heat-resisting cover glasses and lenses for color lighting, control rings, louvers and spill shields to confine the beam to given areas or to prevent splashes of light on surfaces which should not be lighted or which are to be taken care of by other units or other color effects, all necessary accessories for light control.

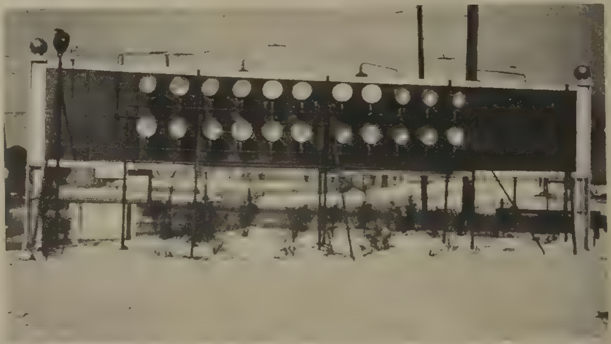


FIGURE 462—The signboard very effectively screens from view the floodlighting equipment installed behind it.

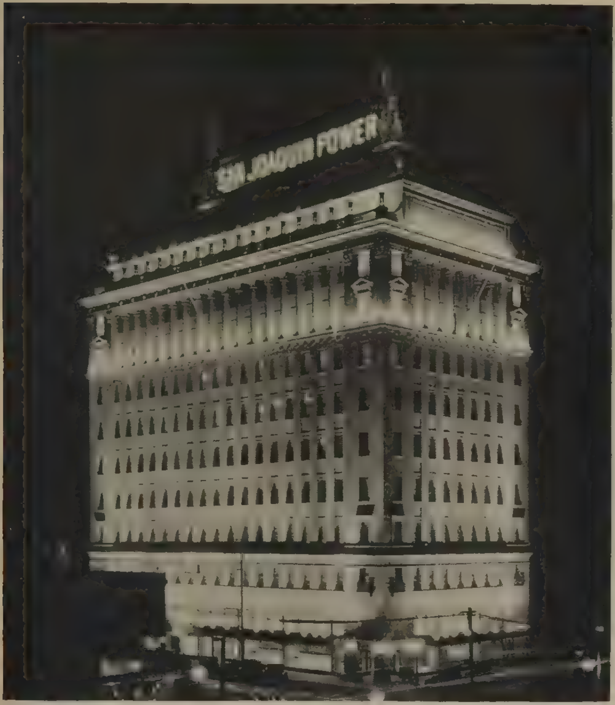


FIGURE 463—*The office building of the San Joaquin Power Company, Fresno, Calif. Floodlighting in colors at night makes this structure strikingly effective.*

Office Buildings

Floodlighting installations were at first merely white light reflected upon the building surface, but newer methods accent and emphasize the ornamentation and indentations of the structure by shadows, high lights, and color.

In general there are two distinct types of floodlighting for buildings. The one in which the light is evenly distributed over the entire surface, and the second or silhouette method for which many portions of the building such as towers, buttresses, minarets, etc., are viewed against a lighted background. The former scheme usually calls for locating the units at a considerable distance from the surface to be illuminated, whereas the latter always requires the projector units to be installed on the building itself. The silhouette lighting presents a most interesting picture. Furthermore, it gives an opportunity for the fascinating color shadow effects that are now becoming popular.

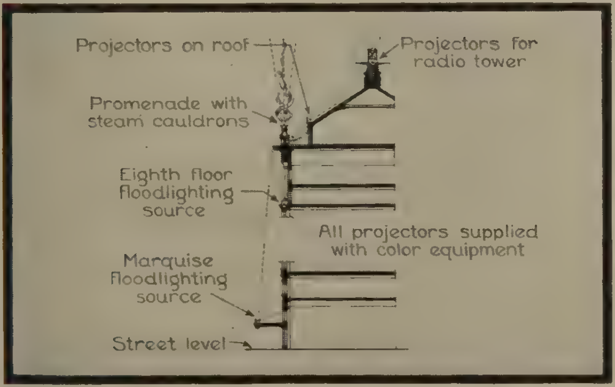

Projectors on roof
Projectors for radio tower
Promenade with steam cauldrons
Eighth floor floodlighting source
All projectors supplied with color equipment
Marquise floodlighting source
Street level

FIGURE 464—*Diagram showing the general scheme of lighting for the San Joaquin Power Company Building.*

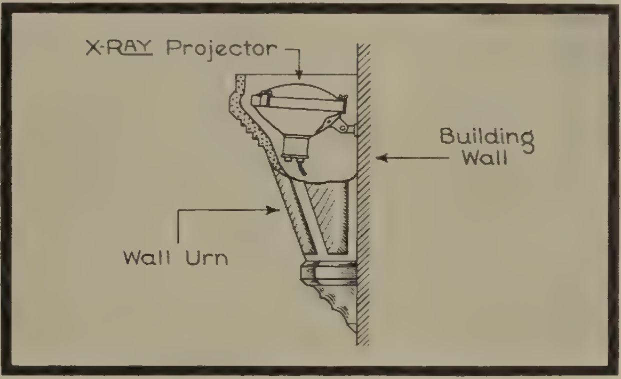

X-RAY Projector
Building Wall
Wall Urn

FIGURE 465—*Detail showing the method for concealing projectors on the surface of the Tulsa Service Building.*

Some of the newer types of buildings, the setback type for example, lend themselves particularly to floodlighting. This is exemplified in the Elverson Building, the home of the Philadelphia Inquirer. At night it is one of the first things to greet the visitor approaching the city. This outstanding spectacle results from the use of one

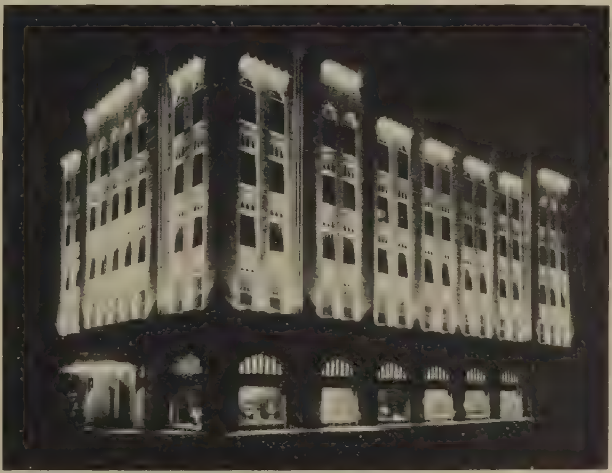


FIGURE 466—*Public Service Building, at Tulsa, Okla. A. M. Aeksol, Architect. A novel floodlighting method in which white and amber tints are employed.*

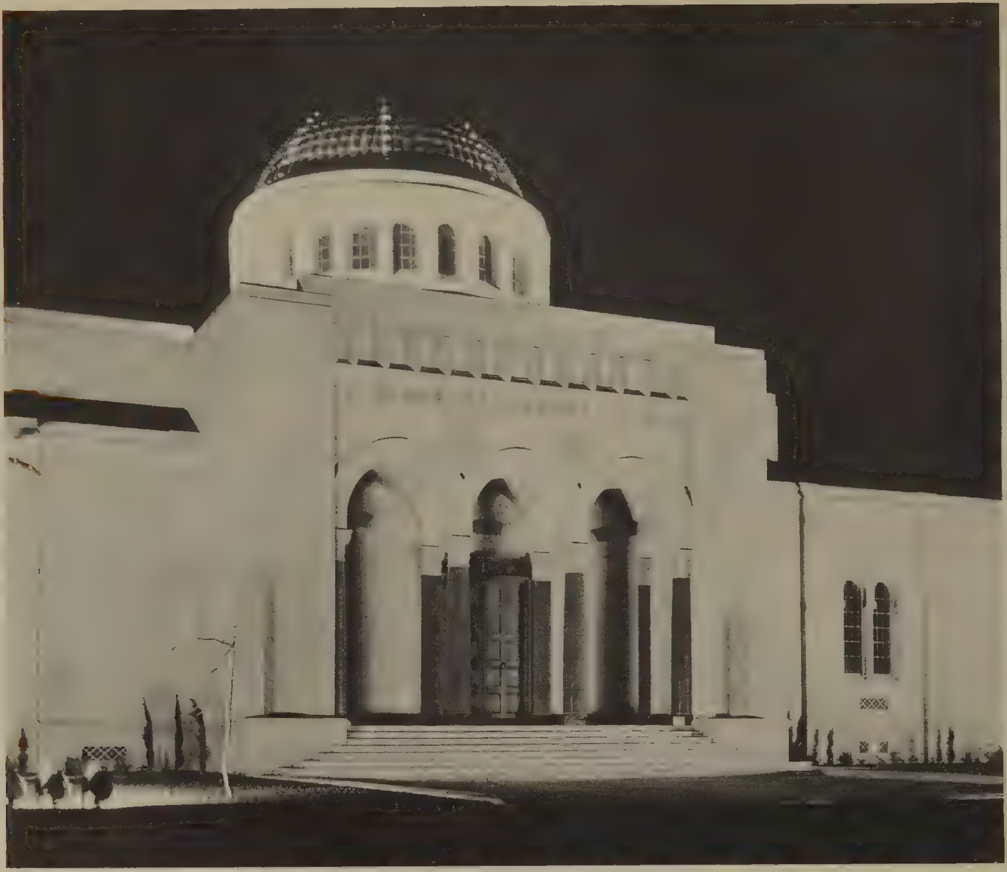


FIGURE 467—Temple of the Entombed, Oak Hill Mausoleum, San Jose, Calif. Robert F. Roller, Architect, San Francisco. An effective and dignified method of illuminating this beautiful building at night.

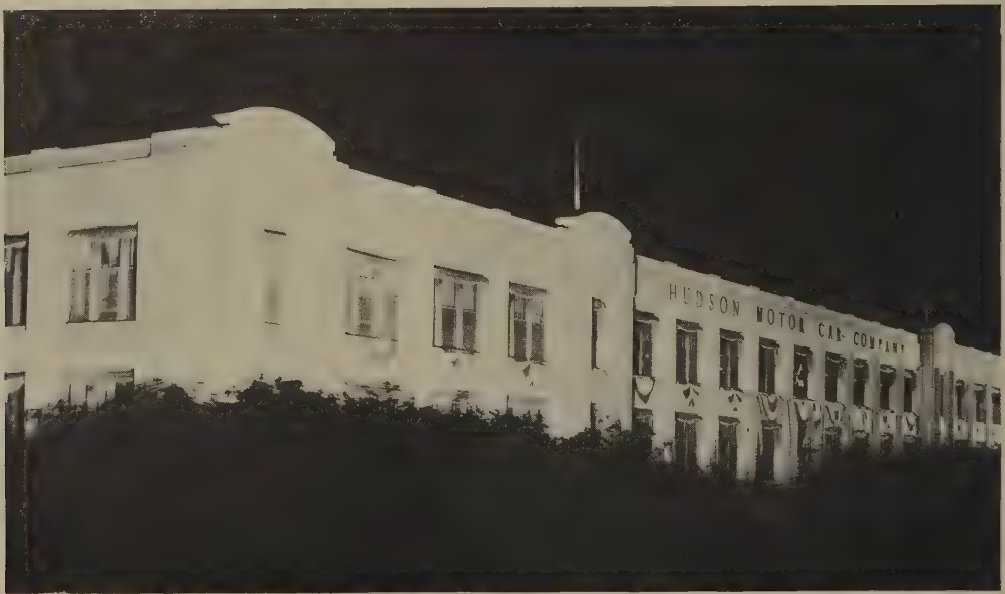


FIGURE 468—Sales Building of the Hudson Motor Company, Detroit, Mich. Six hundred and fifty feet of frontage of this building are brought into prominence by effective floodlighting.

hundred eighty 500-watt X-Ray floodlights operated by remote control from the elevator dispatch room and executive offices. By careful placing all but eighteen units have been mounted on the building itself. The lantern at the top of the structure contains sixteen 500-watt specially designed units, eight of white and eight of red, all operated to automatically flash the quarter hours.

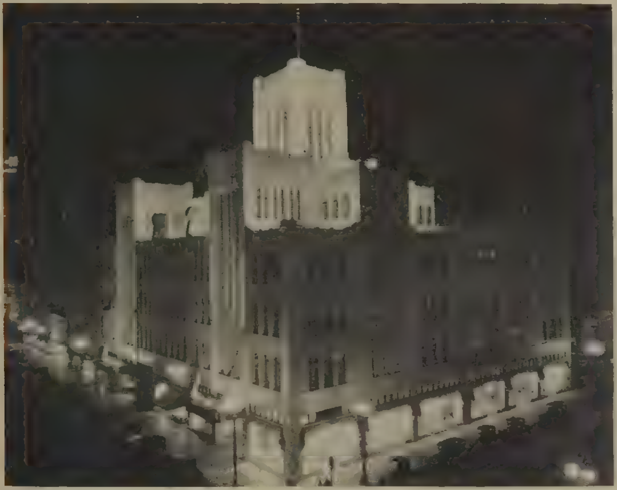


FIGURE 469—A night view of the Wise Brothers' department store, Los Angeles, Calif. Typical of the set-back type of building, especially suitable for floodlighting.

After considering the matter for more than a year, Montgomery Ward & Company decided to floodlight their St. Paul Branch building. Advantageously located on an elevation the main office building of white concrete is about 600 feet long, 50 feet high, with a tower rising more than 250 feet from the ground and visible for a distance of 10 or 15 miles. Since twenty million people pass this building each year, it is impossible to overestimate the advertising value of floodlighting. The building is lighted by two banks of 500-watt X-Ray projectors placed about 200 feet from the building. For the main doorway two groups of units are located 90 feet distant. The tower is illuminated on four sides, with all projectors mounted on the adjacent lower roof levels.

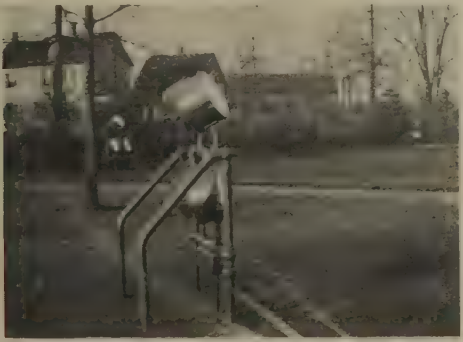


FIGURE 470—An effective method of installing floodlights near the ground on a pipe frame.

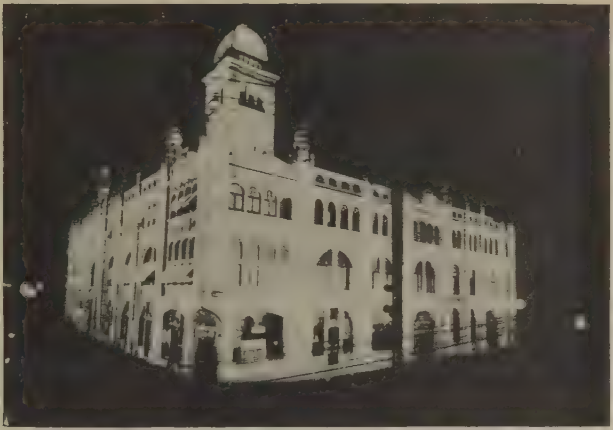


FIGURE 471—The Gonzola Mejia Building, Medellin, Colombia. The tower is floodlighted in the colors of the national flag.

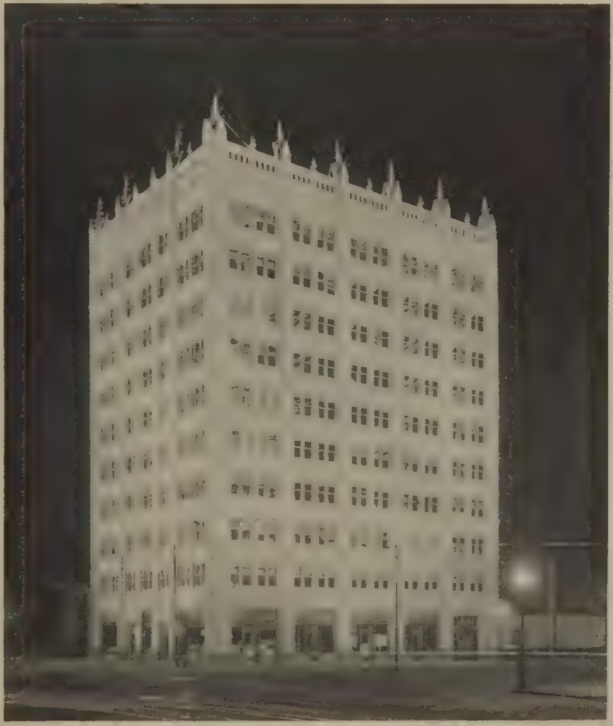


FIGURE 472—National Reserve Life Insurance Building, Topeka, Kansas. R. E. Schammel, Architect. The floodlights are placed upon adjacent structures.

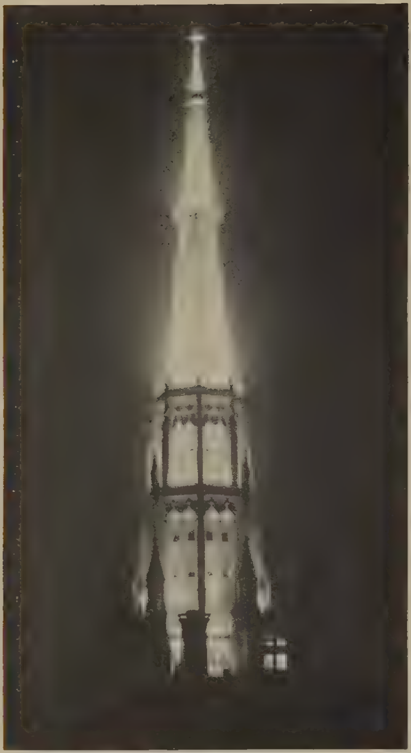


FIGURE 473—Spire of First M. E. Church, Chicago, Ill. Holabird and Root, Architects. An excellent example of the silhouette method of floodlighting.

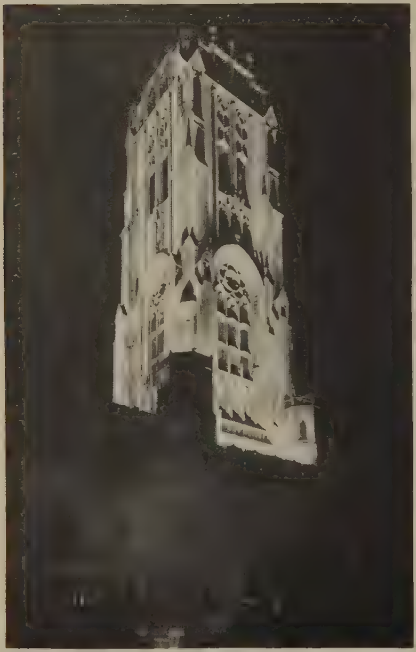


FIGURE 474—Scottish Rite Tower, Indianapolis, Ind. George E. Schrieber, Architect. X-Ray projectors, placed at its base reveal its beauty at night.

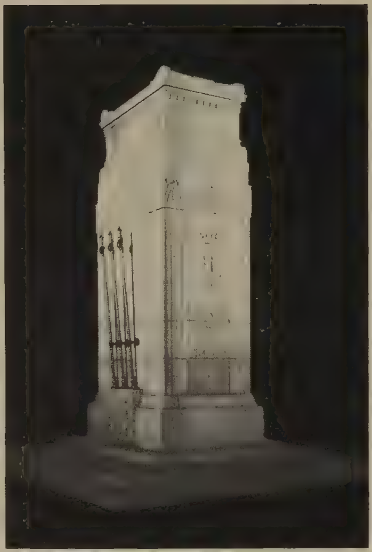


FIGURE 475—The Cenotaph at Calgary, Alberta, is a constant reminder of Armistice Day. Only two X-Ray projectors are required for this lighting effect.

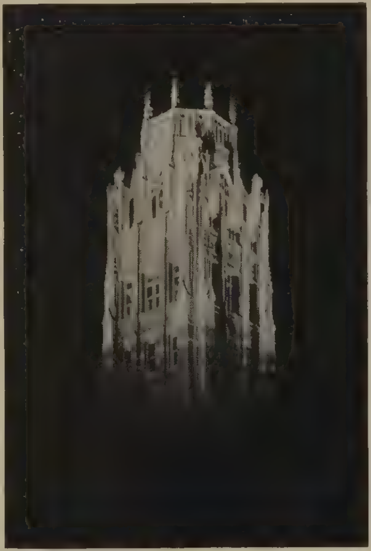


FIGURE 476—The beautiful tower of the Lincoln High School, Manitowoc, Wis., is at night a landmark for the entire country-side.

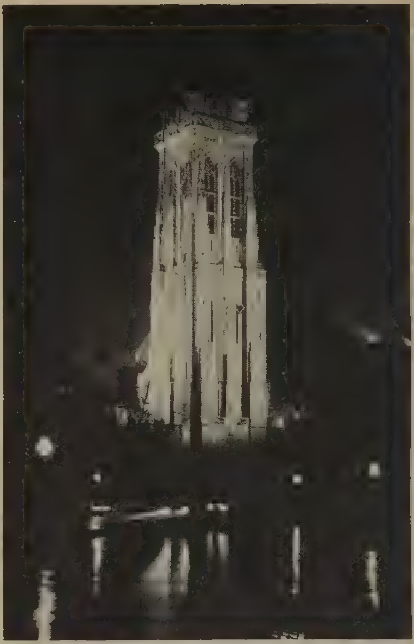


FIGURE 477—The Emanuel Church spire at Baltimore, Md., is illuminated during Christmas week of each year as a feature of the holiday festival of the church.

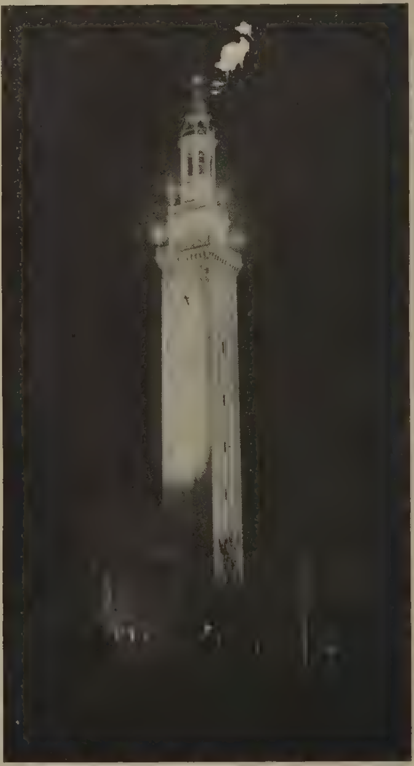


FIGURE 478—The Municipal Tower, Springfield, Mass. Pell and Corbett, Architects. An excellent example of the civic advertising of a beautiful monument.

The San Joaquin Power office building at Fresno, California, is strikingly illuminated by colored floodlighting. The terra cotta and buff brick facing reflects various beautiful tints and shadings. Forty-eight different color arrangements are possible. The light projectors are in three stages. The first group is concealed behind the cornice of the marquis to flood the surface to the eighth floor. At the eighth floor concealed units have been set in the tile spandrel and surround the top of the building with a brilliant light. The surface at the tenth floor is flooded from projectors concealed along the promenade. Huge cauldrons lining the balustrade emit clouds of steam which are caught in colored beams of light.

An unusual floodlighting installation in white and amber is illustrated in Figure 466. Special urns have been designed as a part of the structure to hide the floodlights. Concentrated beams from the units are reflected back to the eye very strongly from the upper cornice of the building. The effect of the vertical beams departs from the usual uniform surface illumination and accentuates the spaces between pilasters.

An idea of the amount of wattage usually employed for the illumination of a building may be gained by noting that for the Mausoleum, illustrated in Figure 467, seventy 500-watt X-Ray floodlights are employed. The front and two ends utilize thirty-two and the rear eighteen, with twenty for the tower. Units are mounted near the ground effectively concealed by shrubbery.

Recently in Medellin, Colombia, a handsome building was completed which bears the name of one of its prominent sponsors, Sr. Gonzalo Mejia, who saw the possibility of making it add to the beauty of this city at night as well as by day. The illumination was inaugurated on a most dramatic occasion, at the time the President of the Republic and diplomatic representatives paid a visit to the city. The walls stand out in natural coloring, while the glass lantern which surmounts the tower shines forth in brilliant red and the sides of the tower in delicate tones of blue and yellow, the National colors of the Republic of Colombia.

Floodlighting is appreciated as an important means of advertising by building owners and managers. We find a good instance of this in Topeka, the capital of Kansas, which takes pride in possessing what it declares to be one of our most beautifully floodlighted office buildings, the ten-story structure of the National Reserve Insurance Company. Forty-nine X-Ray projectors, each of the 500-watt capacity, illuminate it from 8 o'clock until midnight every evening. The projectors mounted on the roofs of buildings occupying corners opposite are placed to conceal the source of light from the view of the observer.

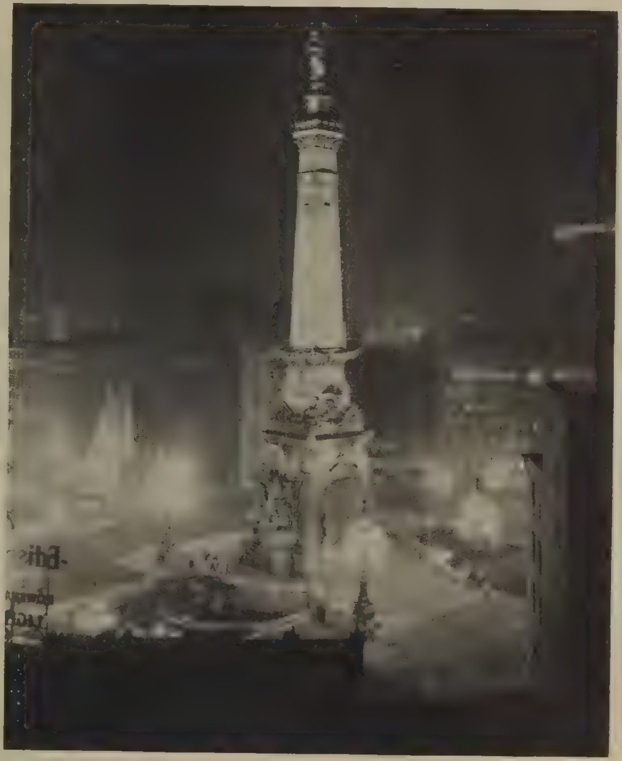


FIGURE 479—Soldiers and Sailors Monument, Indianapolis, Ind. The judicious application of light makes a beautiful night picture of this famous monument.

Monuments and Towers

Many persons are deprived of daylight views of monuments and prominent buildings because of their occupation or place of residence. The evening gives them leisure to enjoy the beauties of the architectural masterpieces. Our parks and squares are adorned with reminders of sacrifices made to secure a united and independent coun-

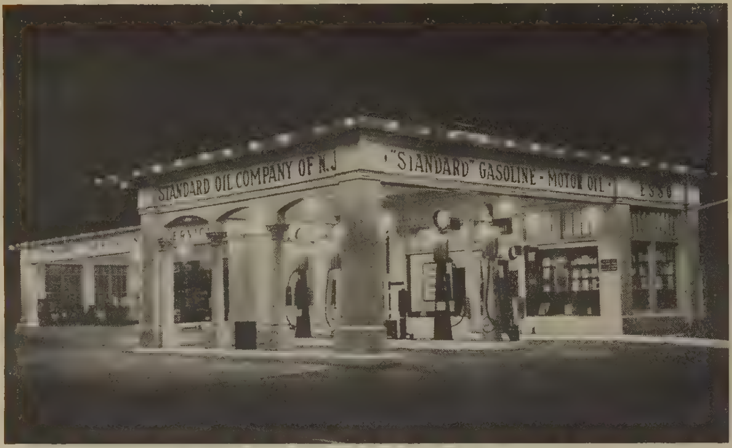

STANDARD OIL COMPANY OF N.J.
"STANDARD" GASOLINE · MOTOR OIL ·
ESSO

FIGURE 480—Standard Oil Company of New Jersey, Baltimore, Md. Well lighted driveway and station without unsightly equipment.

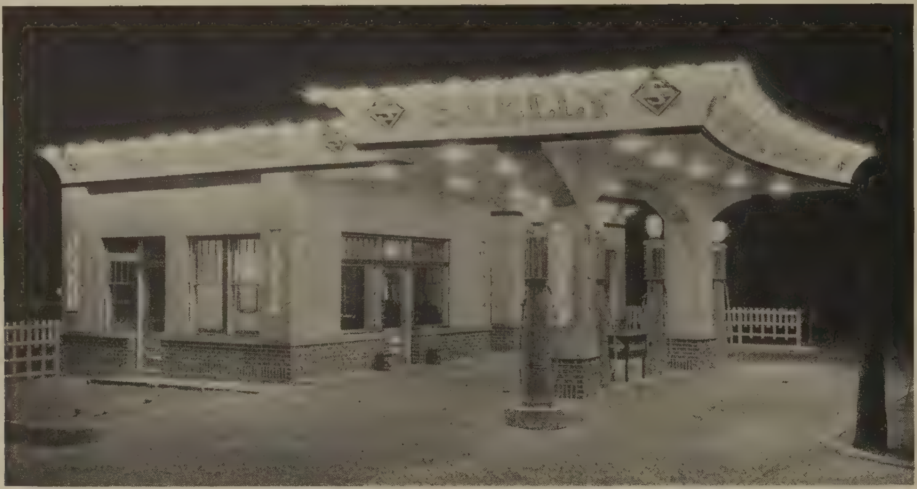


FIGURE 481—Skelly Oil Company, Kansas City, Mo. Special lighting scheme supplies illumination for signs and the ground area around the station.

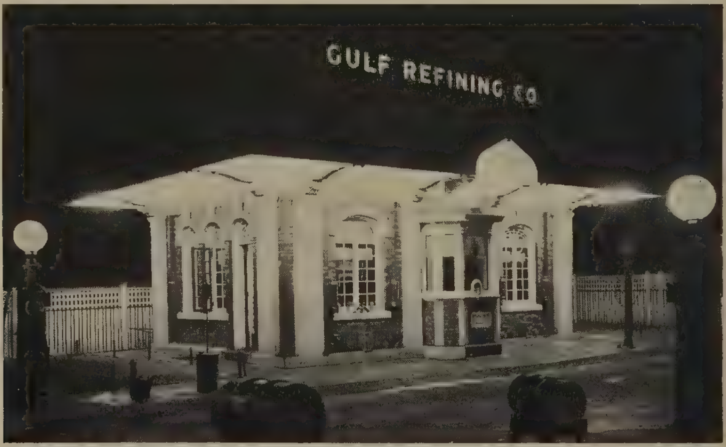

GULF REFINING CO

FIGURE 482—Gulf Refining Company, Pittsburgh, Pa. Lights concealed in the overhanging cornice flood the station with brilliant light.

try. These monuments impressive by day take on a new beauty when floodlighted and leave a memory not easily effaced.

In designing the First M. E. Church, of Chicago, the architects had a vision of the modern office building in terms of the great art of the Middle Ages. The result is a structure of maximum utility, picturesque in design, whose illuminated spire is an inspiration to the seething, striving multitude of a great metropolis. The silhouette idea is employed. The buttresses and projecting elements of the tower are seen against a lighted background. The cross at the top of the spire is illuminated to a much greater intensity than all other portions of the surface. There is a gradual increase of intensity on the surface from base to top of spire.

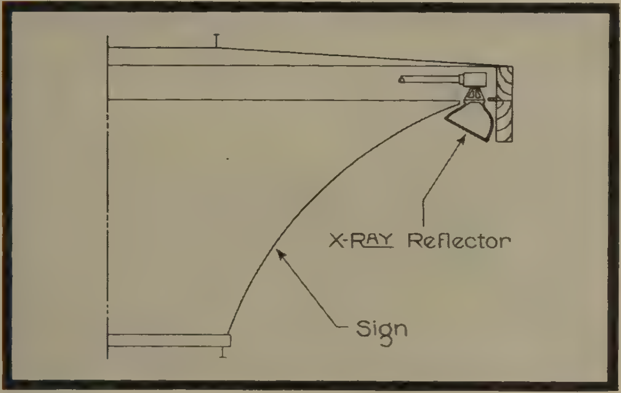


FIGURE 483—Scheme used in illuminating the Shell Oil station shown on opposite page.

The citizens of Springfield, Mass., feel a justifiable pride in its municipal group consisting of Civic Auditorium, Civic Hall, Court House, and Campanile. It is the latter that is shown floodlighted in the illustration of Fig. 478. This beautiful limestone structure stands 300 feet high, and is 50 feet square. The floodlights have been very effectively concealed from view by placing them on the tops of roofs of adjoining structures. Altogether sixty-two X-Ray 500-watt floodlights are employed for the night lighting.

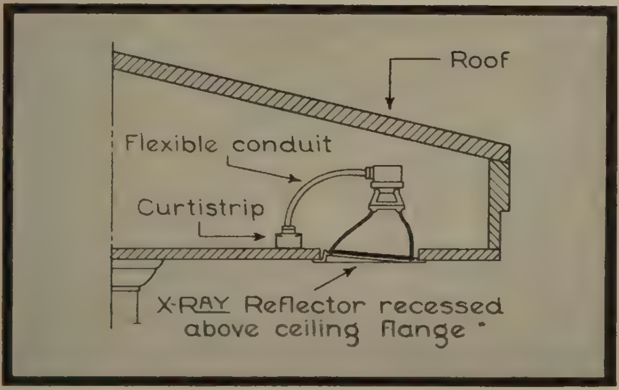


FIGURE 484—The method adopted for the lighting of the Standard Oil station.

As in the case of the Scottish Rite Tower, at Indianapolis, it is frequently more effective to illuminate only a portion of the building rather than the whole structure. This tower, for example, is very strikingly revealed by 40 floodlights that have been installed on the roof of the main building, ten to each side of the tower. Without doubt, this beautiful Gothic structure creates a much greater impression at night than it does by day, because it is so effectively isolated by light.

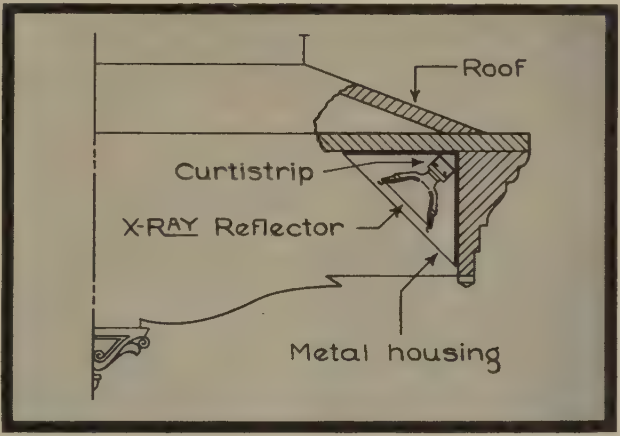


FIGURE 485—Special concealed lighting designed for Gulf Refining Company filling station.

Auto Service Stations

The operators of gasoline service stations have two principal problems, first being to attract customers to the establishment, and then to give them proper service. Light can assist to make both of these factors effective. Good lighting for a gas station does not consist of a blare of light from large wattage lamps. Bright surroundings are properly obtained only by reducing glare and illuminating building surfaces and grounds.

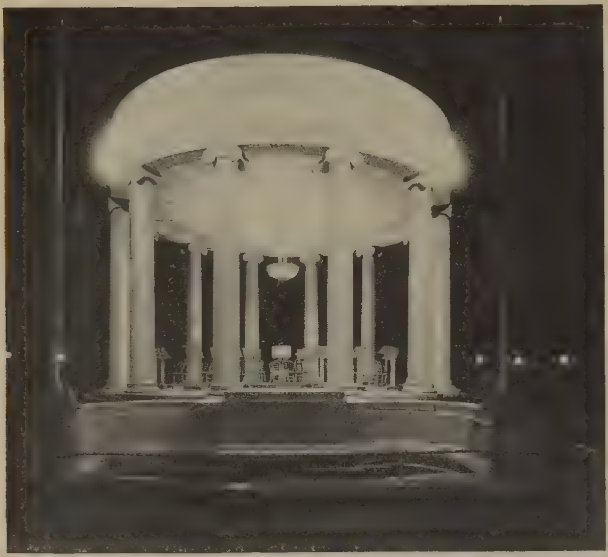


FIGURE 486—Band stand in a city park. Floodlighting brings the structure into prominence. The indirect lighting fixture furnishes proper illumination for the players.

The well lighted driveway and station of the Standard Oil Company, shown in Figure 480, is accomplished by small X-Ray reflectors for 60-watt lamps so installed that the daytime view is not obtrusive, concealed in the overhanging eaves, and spaced at intervals of 24 to 30 inches so that the maximum flux falls upon the building.

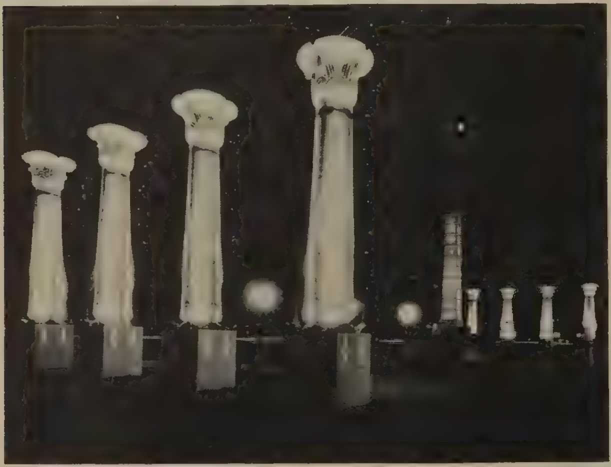


FIGURE 487—Decorative columns of the Garden of Allah for a Shrine convention. Harry A. Hake, Architect. Floodlights, mounted at the bases of the columns illuminate the shaft.

An additional problem was encountered in the lighting of the station for the Skelly Oil Company, because of the presence of the sign on the cornice. A projecting decorative apron hides a series of X-Ray reflectors which serve not only to illuminate the sign, but also the sides of the building, and contribute largely to the illumination of the driveways and area surrounding the station.

Special Applications

One hundred columns twenty-five feet high were used for a Shrine Convention as one of the features of the decorative scheme. By concealing an X-Ray 250-watt projector in a lotus leaf design on the base of each column, an extremely effective result was obtained at a nominal cost.

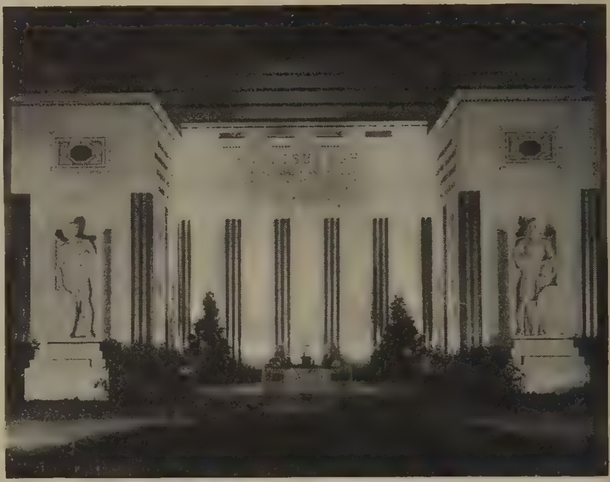


FIGURE 488—The Pittsburgh Building at the Sesqui-centennial Exhibition, Philadelphia, Pa. E. B. Lee, Architect.

An old Dutch windmill, purchased by a syndicate owning a tract of land near a large city, was used as a means of advertising. By the installation of a series of fifteen 500-watt floodlights placed at a distance of 120 feet from the mill, the four sides of this historical and unique structure were

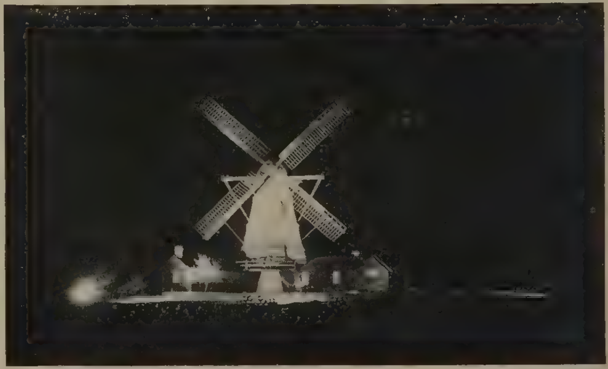


FIGURE 489—Added value and meaning are given to landmarks and historical objects when floodlighted at night.

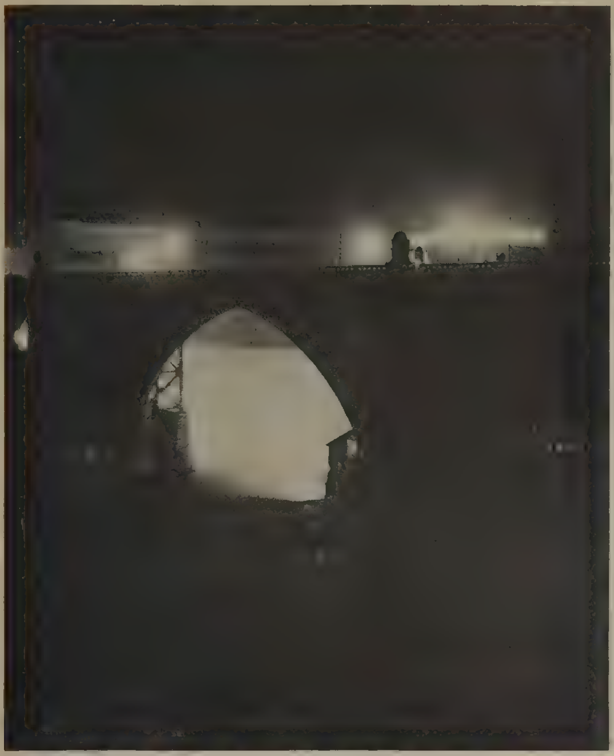


FIGURE 490—Spokane Falls, Spokane, Wash. Thousands of tourists are attracted to these beautifully lighted falls.

so illuminated at night as to be seen from many important highways for many miles around.

The City of Spokane is proud of the fact that it has the largest waterfall in the United States within the limits of any municipality. It was strongly recommended by many of the townspeople that these beautiful falls be illuminated, especially during the tourist season, because at this time of the year spectators are very much impressed by its beauty.

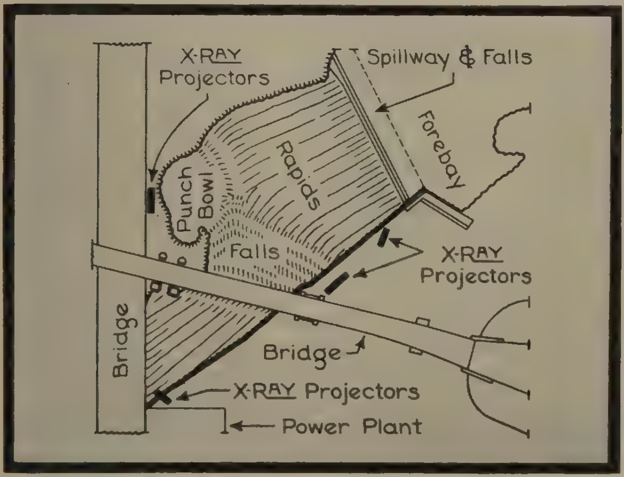

X-RAY Projectors
Spillway & Falls
Forebay
Rapids
Punch Bowl
Falls
X-RAY Projectors
Bridge
Bridge
X-RAY Projectors
Power Plant

FIGURE 491—Plan showing the location of X-Ray projectors for lighting the Spokane Falls.

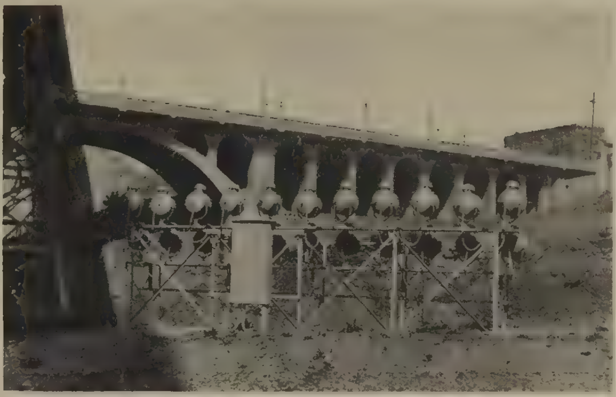


FIGURE 492—Portion of the lighting equipment used for the Spokane Falls, showing method of installation.

The result obtained by the installation of floodlights is shown in Figure 490. A total of sixty-two 1000-watt units installed in four banks were utilized. Some of the units are equipped with color screens to add to the variety of the illumination.

Floodlighting is one of the best means of illuminating signs. The Martha Washington Candy sign is 35 feet high and 45 feet long. At a distance of thirty feet in front of the sign are mounted three 250-watt X-Ray projectors equipped with reflectors for distributing the illumination. The result is a perfect evenness in brightness.

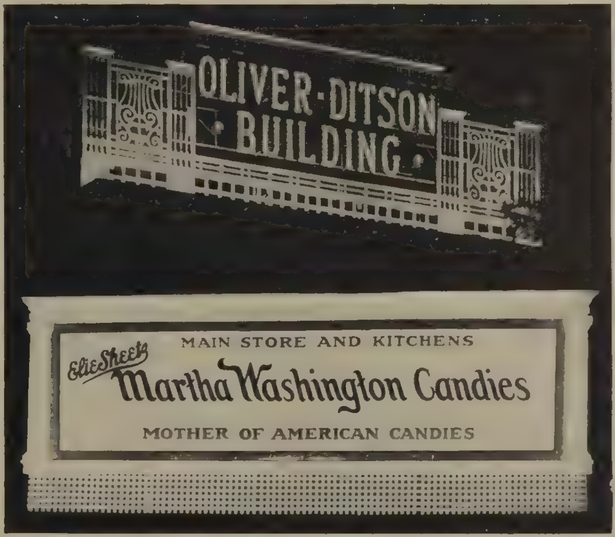

OLIVER-DITSON BUILDING
MAIN STORE AND KITCHENS
Elie Sheetz
Martha Washington Candies
MOTHER OF AMERICAN CANDIES

FIGURE 493—The floodlighting of billboards is one of the most effective means of outdoor advertising.

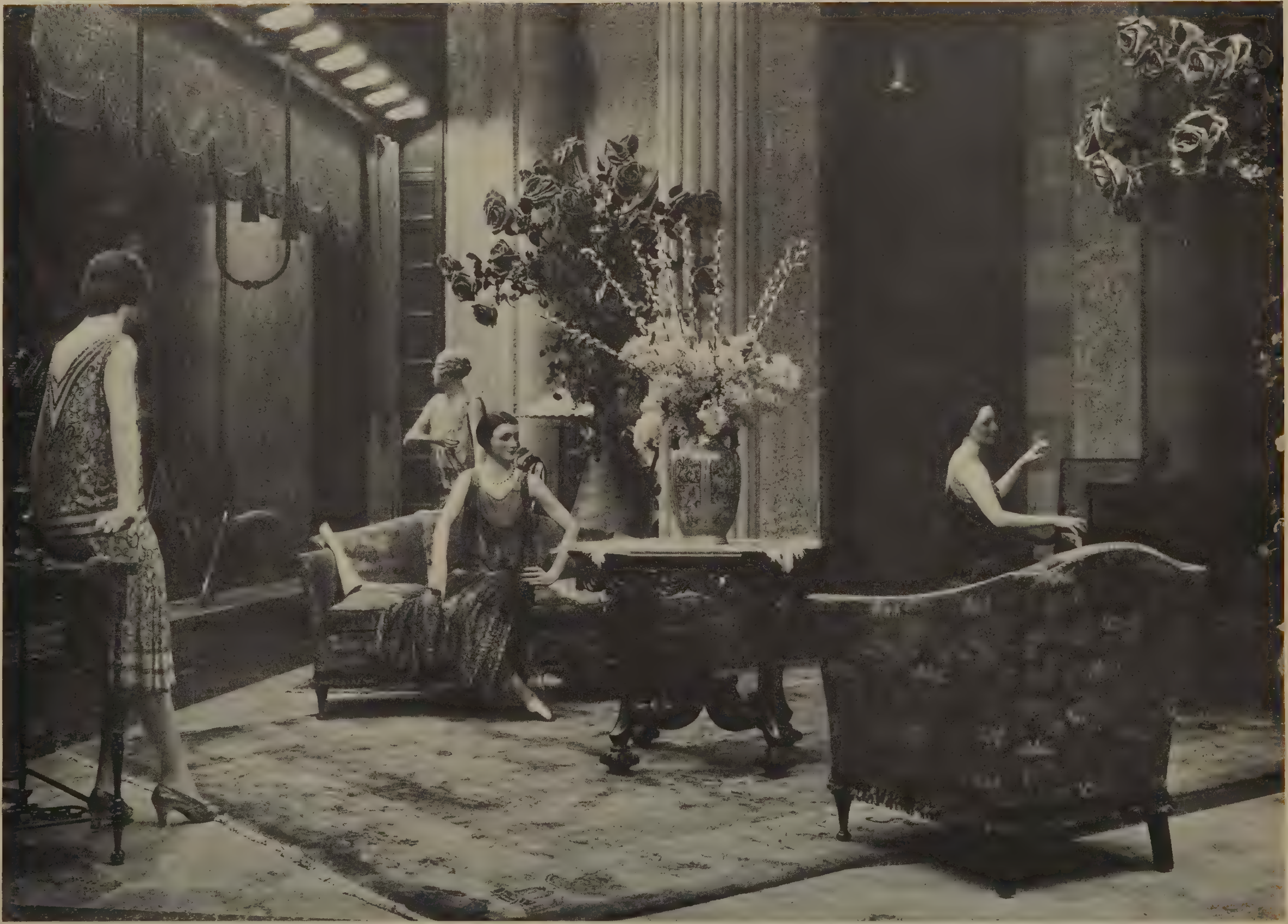
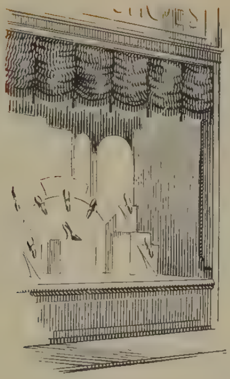


FIGURE 494—A show window of the O'Niel Store in Akron, Ohio. Graham, Anderson, Probst and White, Architects, Chicago. An example of proper and satisfactory lighting for a refined and beautiful display.



SHOW WINDOW LIGHTING

HISTORICALLY, the showing of goods for sale is an old idea, but window lighting displays as we see them today are of modern origin. A moveable box sufficed for the ancient fakir. In the middle ages the shutter for an opening in the wall performed the duties of roof and counter. Permanent windows came with the invention of plate glass in the thirteenth century when the English used small panes or panels for the glazing. In the seventeenth century rapid advances were made in shop window construction and by the middle of the nineteenth century developed to such elaborate proportions as to become a most important part of the mercantile establishment, requiring in the larger stores the attention of experts in display management.

Today, therefore, the display decorator cooperates with the sales executives of stores in getting the greatest return for the large investment in window space by carefully planned exhibits. The success of the display man's effort depends upon vision, and since light is essential to vision, the closest relation exists between his art and proper lighting. Without doubt the first function and advantage of light in the show window lies in its attraction value. Better lighting will stop the passer-by while a scheme of illumination thoroughly planned for maximum return is a weapon of competition and a definite builder of sales.

The use of lighting may be such as to attract and stop the man in the street because of its novelty in application or its color, yet it may be wholly lacking in its value as a sales aid. Good lighting does more than attract; it must increase the buying urge. In any case, it must not be so apparent or conspicuous as to detract from the

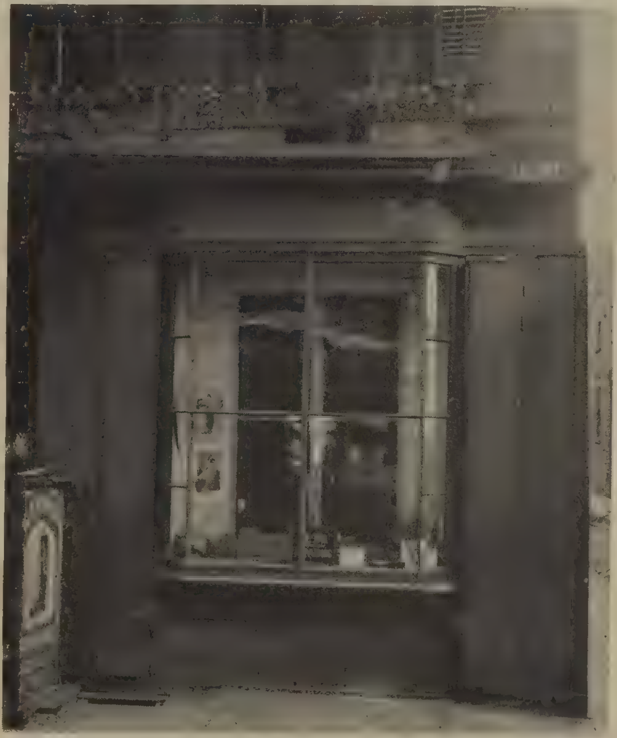


FIGURE 495—The show windows of a hundred years ago, with their shutters and candle-light, contrast strongly with our present day methods of display.

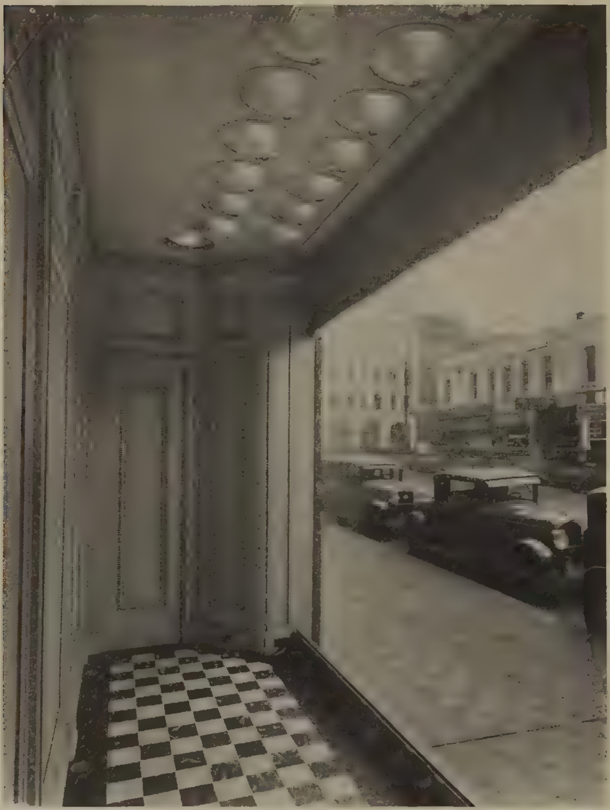


FIGURE 496—A modern shop window properly equipped with lighting devices, including overhead reflectors, floodlights, and footlight equipment. This is a show window of the Birmingham Electric Company, Birmingham, Alabama.

goods on display. The prospective customer should not be conscious of the means or the lighting effect as a thing detached from the display as a whole. The lighting is fundamentally a part of the setting and should be so planned.

The display space in the front of the shop is the most valuable area in all the store. The more effectively it is used the less will be the proportional charges against it. Every window has an actual value and, likewise, a potential value. It is a sort of advertising and business-getting laboratory, a medium of wonderful interest and possibilities, entirely within our control, producing results that may be measured.

The art of shop window illumination has developed in three major respects. First, better lighting sources have been made available through a long period of years. Candles were replaced when petroleum lighting was adopted. Then came gas lighting, and finally the incandescent lamp. Important changes followed when thought was given to the placing of the lamps in the show windows to avoid harsh glare in the eyes of the onlooker. Finally came the utilization of the scientific principles of light control to conserve losses of light and to increase its effectiveness. It is in the two latter respects that Curtis Lighting, Inc., did the pioneering. Practically every innovation in this important field of modern lighting application can be attributed to this organization. It is a natural consequence then that the X-Ray reflector has long since been universally considered as "standard for show windows."

The completely equipped show window of today has a full complement of overhead lighting reflectors switched on several circuits for flexible control. It is also provided, for special displays, with facilities for using footlights, either of a permanent type or a portable style, such as described on Page 301, that may be stored away when not in active use. Convenience outlets are an important essential for utilizing the show window floodlight, the spotlight, and mechanisms for motion. Background illumination is effective, just as for stage settings, and should be considered in planning. Color adds finesse. All reflectors should have a complete assortment of easily applied filters and be wired for mobile color by Lumitone control, as described on Page 56. Finally, reserve

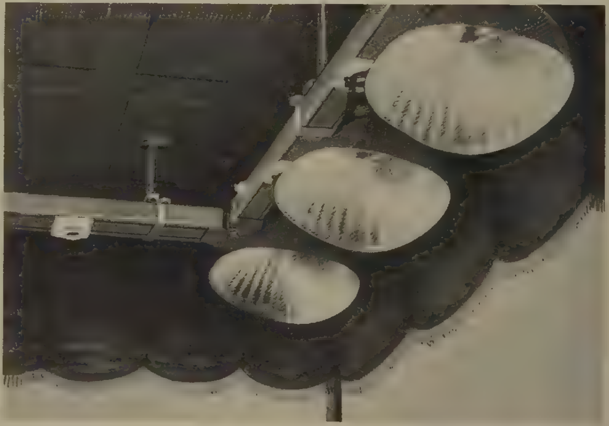


FIGURE 497—A typical show window, indicating the correct manner for the installation of the overhead X-Ray reflectors on Curtistrip, an economical wiring device described in detail on Page 303.

FIGURE 498—A window of the Pogue Store, Cincinnati, Ohio. H. E. Hake, Architect. Illustrating the annoying effect of daylight reflections. This and adjacent picture are daytime photos.

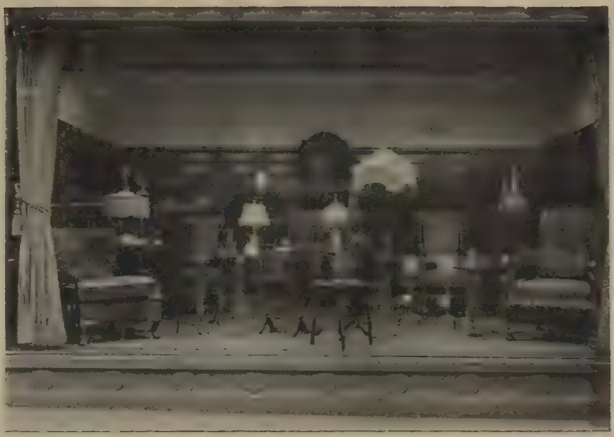


FIGURE 500—The Pogue Store show window after the installation of lighting equipment to minimize daylight reflections. Compare this with the illustration in Figure 498.

wiring capacity should be installed to care for the future demands and changes in lighting practice.

Super-Lighting

One of the recent contributions of Curtis lighting engineers to show window illumination is known as super-lighting, which has been promoted primarily to meet the pace setting demands in modern merchandising. Super-lighting as applied to shop windows supplies the means of doing two things in particular; first, the increasing of the attraction value of the display; second, the reduction of annoying reflections due to the daylight striking the plate glass at the critical angles suggested in Figure 499. Super-lighting is not intended to supersede standard methods, but rather to supplement them whenever high intensities are desired or where unsatisfactory daylighting occurs. To serve its definite purposes it may be installed independent of the regular equipment already in use. Numerous tests have been recorded showing that the use of equipment arranged to give high intensity values caused more people to be attracted by the display than for values commonly found in shop windows. Interesting stories have been told how disturbing daylight reflections are practically overcome by using 200 to 500 foot candles of artificial illumination to supplement the daylight.

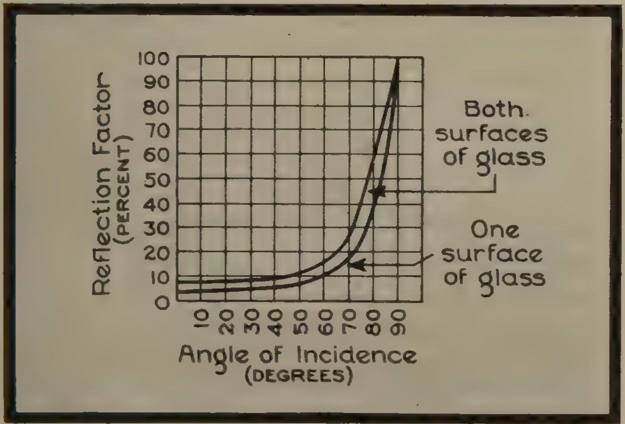


FIGURE 499—A diagram to indicate the percentage of light reflected from plate glass for various angles of incidence.

Show windows are most valuable in the daytime. Frequently, however, due to disturbing daylight reflections, much of their value is lost. For example, in a particularly difficult situation a store owner used 300-watts per each lineal foot of store front with X-Ray reflectors and found by actual count an increase of 93% in the number of persons stopping to view his displays. The cost per current for the daytime lighting was computed at 1/25 of a cent for each person that stopped. Actual daylight photographs showing the effects of super-lighting on increased visibility of the display are given in Figures 498 and 500. The Pogue Store show windows use the X-Ray reflector No. 910, spaced 20 inches apart, and equipped with 500-watt lamps. The equipment that has been designed especially for the purpose of super-lighting is shown and described on Page 299.

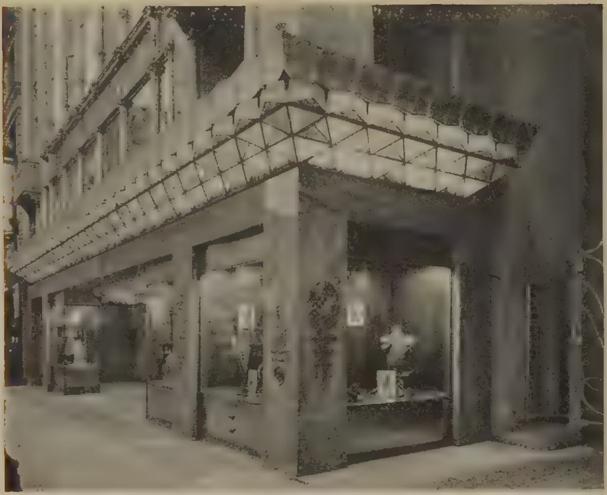


FIGURE 501—*Show windows and entrance of Alexander Oviatt store, Los Angeles, Calif. Feil & Paradise, Architects. Changing color effects are an attractive feature.*

Moderne Lighting

Reference has previously been made to the application of light as an architectural element, and as further emphasizing this point the illustration in Figure 503 is of interest. The scheme of illumination involves a special construction problem inasmuch as the glass ceiling must be suspended so that the lighting reflectors placed above it are accessible, and also in such a manner that no objectionable shadows will be cast. In this particular instance the indirect method is employed. Light from X-Ray reflectors is directed upward to the painted concrete ceiling and reflected downward through the decorative glass below, thus a uniform distribution is obtained and shadows of mechanical equipment and supports are eliminated. The reflecting elements are accessible through the removal of the panels of glass. Provision is made for white light only over the arcade space, while the glass cornice of the store front, shown in Figure 501, has equipment to give color effects combining red, blue and green in changing combinations on dimmed circuits producing many beautiful and attractive variations.

Since window lighting is a form of advertising, it follows the definite trends of business-getting effort. Only a few years ago almost all printed advertisements appeared in black and white, then color was introduced. This trend was reflected in the lighting of show windows. For many years the merchant and display decorator had only white light with which to deal. Later on color lighting effects were introduced first in fixed tones and later in the more interesting mobile expressions.

In this age of color tinted illumination in the show window is a most subtle tool in the hands of the display decorator who uses it with knowledge and taste and appreciates its great artistic value.

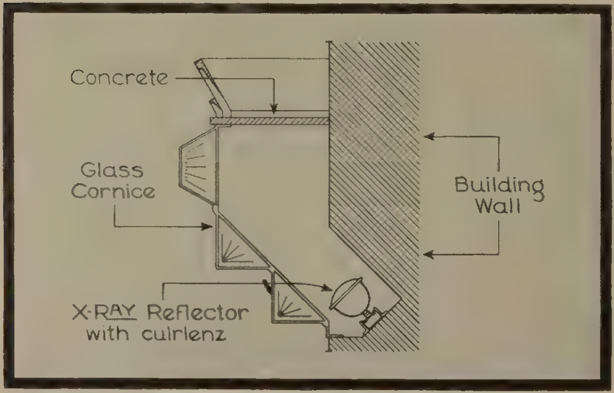


FIGURE 502—*Detail of the scheme for lighting the cornice of the Oviatt store. X-Ray reflectors for color lighting are on automatically dimmed circuits.*

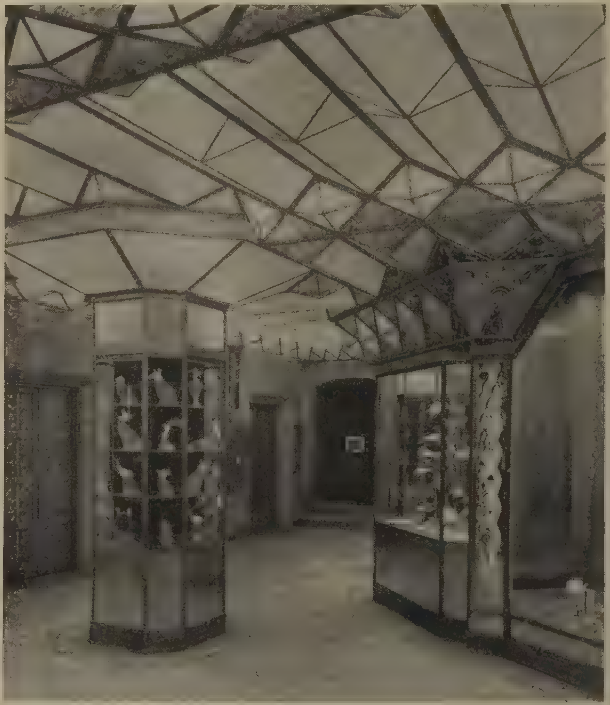


FIGURE 503—*Arcade of the Alexander Oviatt store. The decorative ceiling in modern art is illuminated by X-Ray reflectors placed above it.*

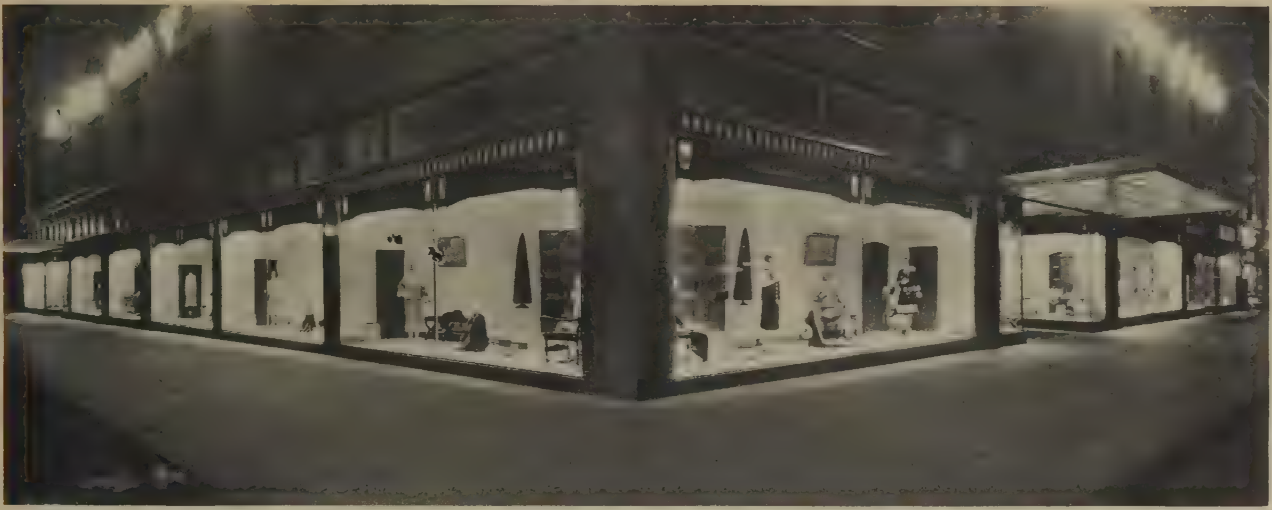


FIGURE 504—The store front of the Nebraska Clothing Company, Omaha, Nebr. James T. Allen, Architect. Typical of "up to the minute" merchandising establishments. All show window reflectors are hidden from view, spaced on 14 inch centers and wired for 500-watt lamps.

The appearance of goods with tinted lighting is very important and as an aid in the proper use of color some important tables have been included on Page 311 that will be found helpful.

There is a time worn statement comparing the show window to the stage. This analogy will be more complete as the application of color in show window lighting progresses. There is no doubt but that the display decorator has many times looked with longing at the marvelous effects produced on the stage and realizes what can be done in his own window setting by the general use of colored lighting. Reflectors, filters, and other accessories for these effects are described on Page 300.

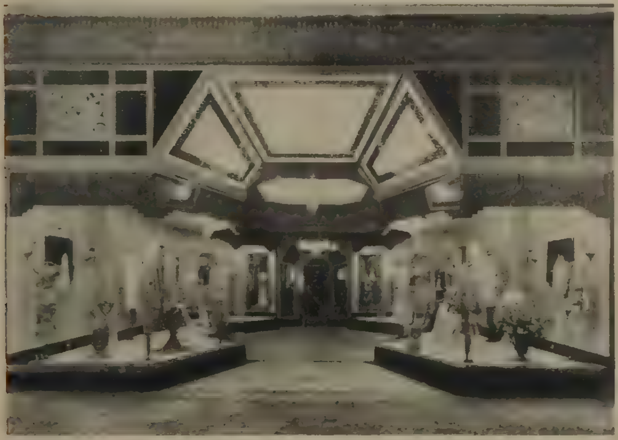


FIGURE 505—Show window of Zukor's, Spokane, Wash. McClelland and Pinneh, Architects, Seattle. High intensity lighting with special illumined panels featured for the entrance.

Color lighting does not mean the installation of a new window lighting system. The same reflectors with the same lamps are used. The only additional equipment necessary is a set of inexpensive frames with sheets of color filter of various tints which fit on the standard X-Ray reflectors. An ordinary window may be transformed into a thing of great beauty that will quickly draw crowds by the addition of color to the lighting. The possibilities of working out vivid and artistic effects in the show window are almost unlimited.

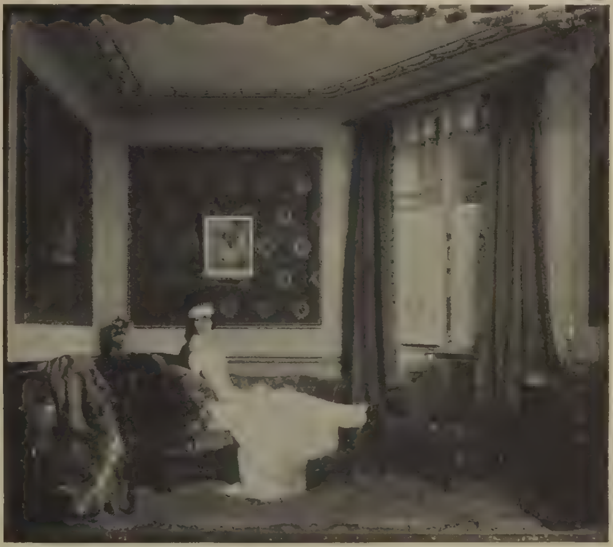


FIGURE 506—A special display, Madame de Récamier, in Le Grand Passage, Geneva, Switzerland. The installation was by Trolliet Fréres, Geneva.

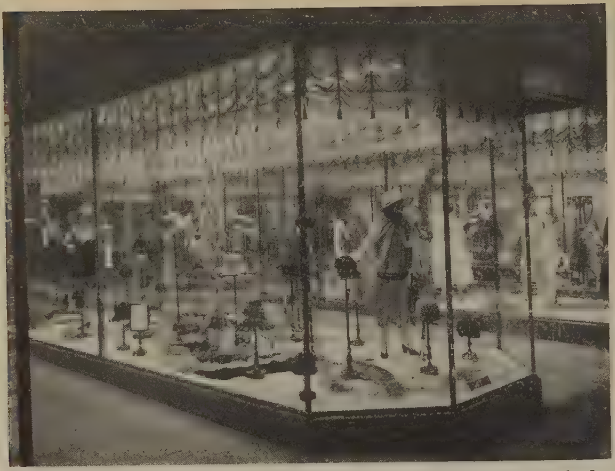


FIGURE 507—The elaborate system of show windows of the Frank & Seder store, Philadelphia, Pa., illustrates the merchant's faith in the advertising value of good lighting and large display.

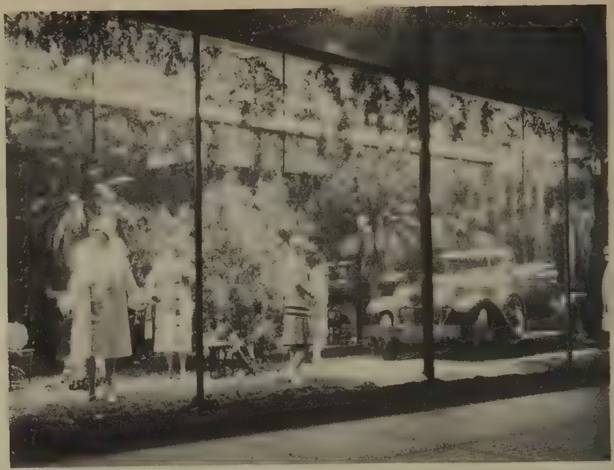


FIGURE 509—The island window of the Chas. A. Stevens Brothers, Chicago. A special installation of high intensity window lighting using 500-watt X-Ray floodlights arranged for color.

Large Window Area

The merchant's faith in the value of shop window displays and effective lighting is exemplified by the area devoted to this department of the store. In Figure 507 we have an outstanding example of a progressive retailer's idea of what a proper display should be. The Frank & Seder Company, of Philadelphia, has devoted an unusual amount of area to merchandise display with 5200 square feet behind plate glass. Effective lighting equipment plays a vital part for the store in its direct advertising effort. The windows consist not only of the large cases adjacent to the street, but include a series which are separated by arcades. This enormous amount of space gives the establishment an opportunity for elaborate presentations and the producing of lighting effects not obtained in the ordinary type of window.

The store is 80 feet wide, the window lobby 65 feet deep. In this space are nine attractive aisle windows with five auxiliary display windows against the walls of the front, as shown by the plan in Figure 508. Each window has its own lighting system with X-Ray reflectors on 12 inch centers. Color lighting has been effectively utilized for seasonable and special merchandise.

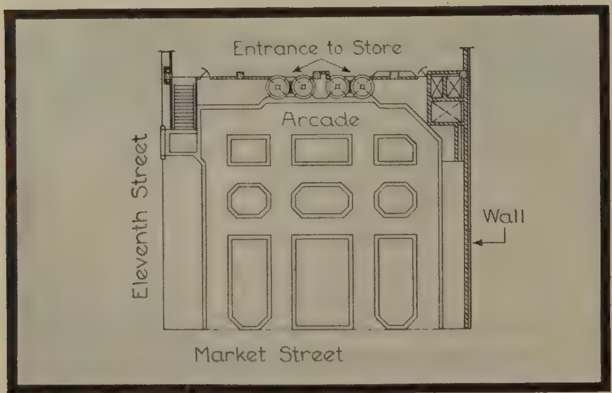


FIGURE 508—Plan of the Frank & Seder store, showing location of its elaborate and attractive show windows.

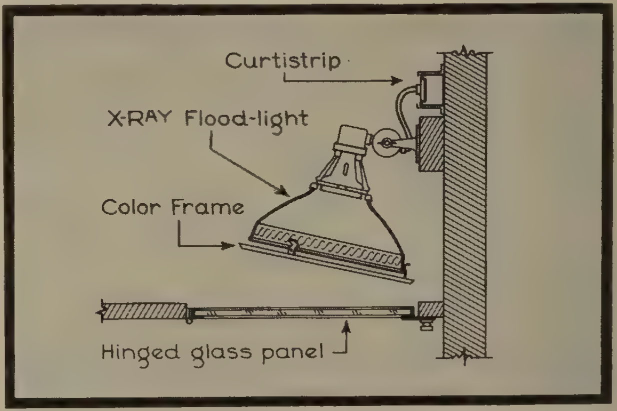


FIGURE 510—A detail showing the method used for illuminating the island window of the Stevens store.

Wattage Suggestions

Lighting recommendations are frequently made on the basis of population of a town or city. In other words, a lesser wattage is required to outshine the competitor on the business street of a small town than in the great white ways of the

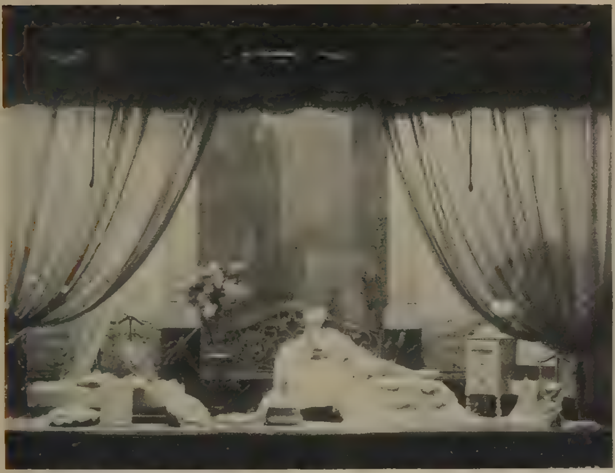


FIGURE 511—*Window of The Fair, Chicago. Typical example of extremely large show window properly illuminated.*

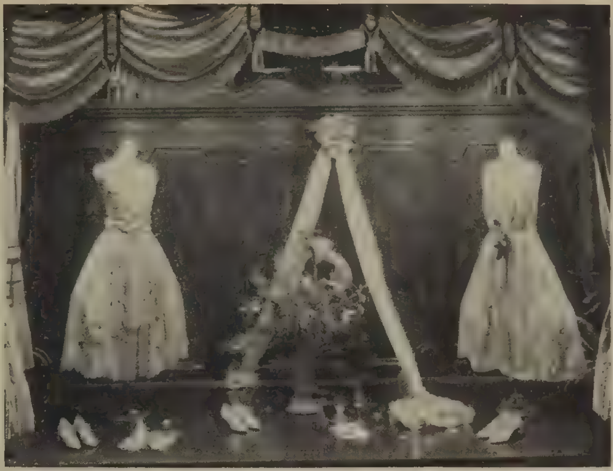


FIGURE 513—*Typical "boxed-in" show window of Smith, Kasson & Company, Cincinnati, Ohio. Tietig & Lee, Architects.*

large metropolitan cities. The type of equipment and number of reflectors to use in a show window is optional with the merchant. No set rule can be established. A number of conditions influence the selection such as the brightness of neighboring windows, the intensity of the street illumination, the kind of goods on display, the color and nature of the window background, and, most important of all, the merchant's realization of the selling value of engineered illumination in merchandising. Some simple rules, however, may be helpful in guiding the one who must discriminate in the selection of equipment. In general the downtown sections of a metropolitan city should have reflectors with 300 to 500-watt lamps spaced on 15 inch centers. For the community center of a metropolitan city and for an outlying district of a city of 100,000 or over, 200-watt lamps are recommended spaced at 12 inches apart. In the outlying districts of a metropolitan city, or uptown section of a city of 25,000, the lamps may be 100 or 150-watt on 12 inch to 18 inch centers. Satisfactory lighting in show windows of the business section of municipalities of less than 25,000 population is obtained by the use of 100 or 150-watt lamps on 24 inch centers.

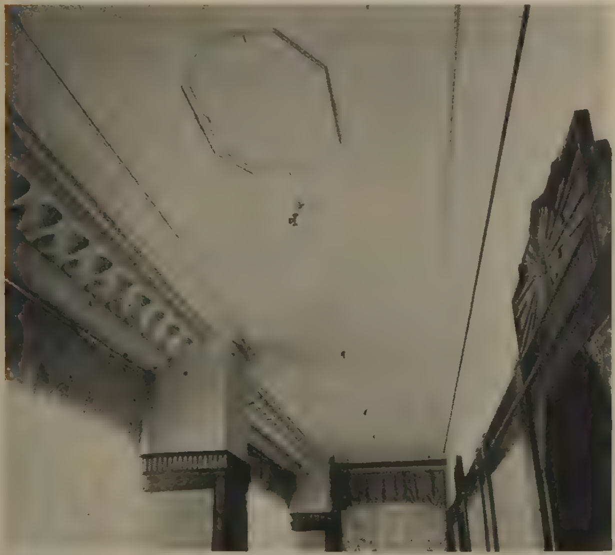


FIGURE 512—*View of ceiling showing concealment of reflectors in a false beam. The store of O'Connor-Moffatt, San Francisco, Calif. Lewis P. Hobart, Architect.*

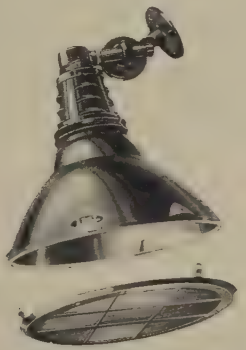


FIGURE 514—*The X-Ray unit No. 33, designed especially for floodlighting effects in show windows, with or without color.*

In addition to the overhead reflectors that are ordinarily installed in the show window, certain types of accessory equipment are helpful in emphasizing various displays. The floodlight is a

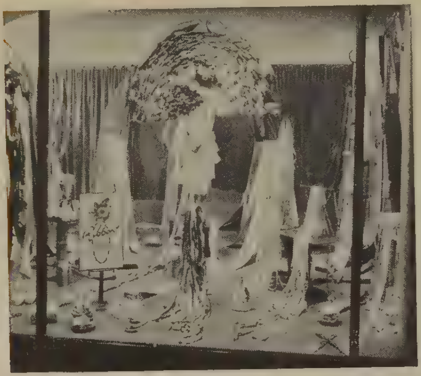


FIGURE 515—Abrahams, Ltd., of Lambton Quay, Wellington, New Zealand.

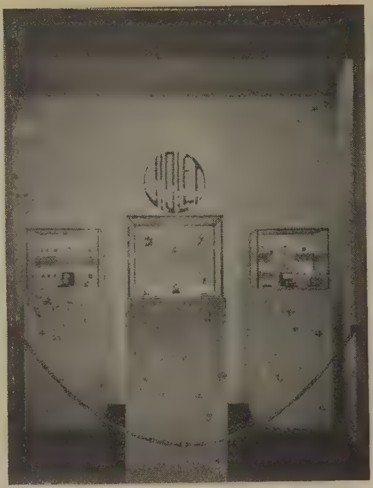


FIGURE 518—Parfums Violet, Paris, France.

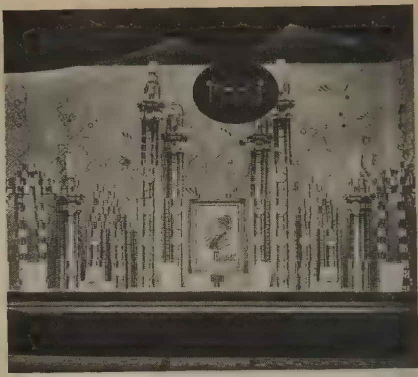


FIGURE 520—Display of cigarette shop, Brussels, Belgium.

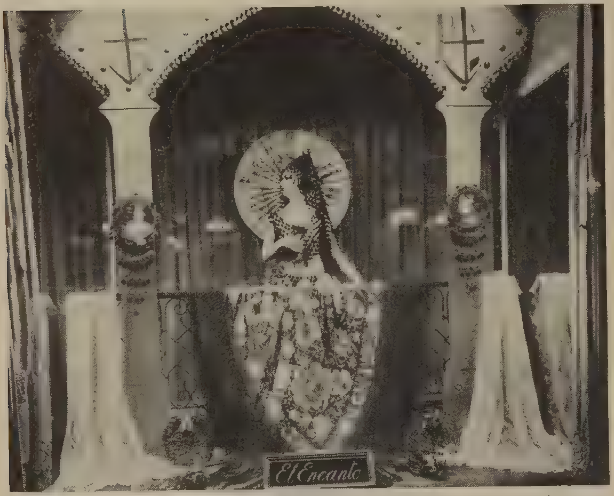


FIGURE 516—El Encanto department store, Havana, Cuba.

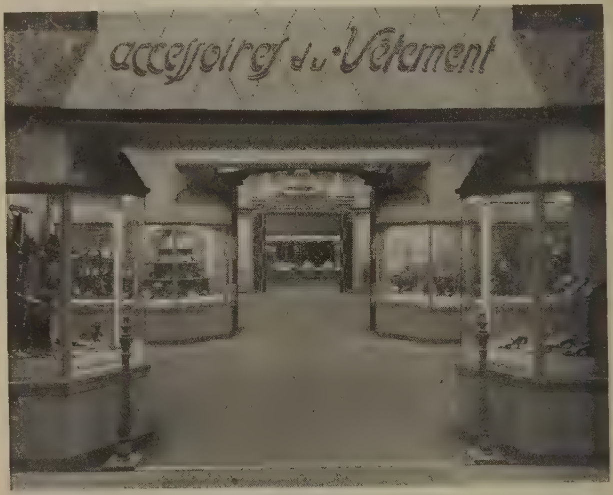

accessoires du Vetement

FIGURE 521—Exposition of Decorative Arts, Paris, France.

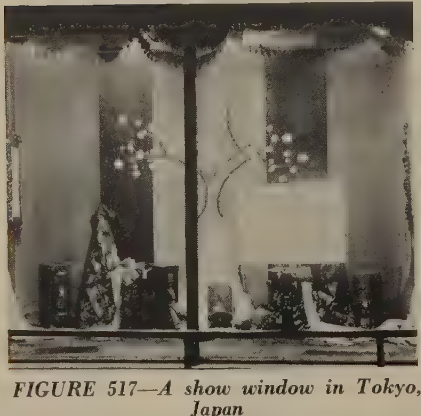


FIGURE 517—A show window in Tokyo, Japan

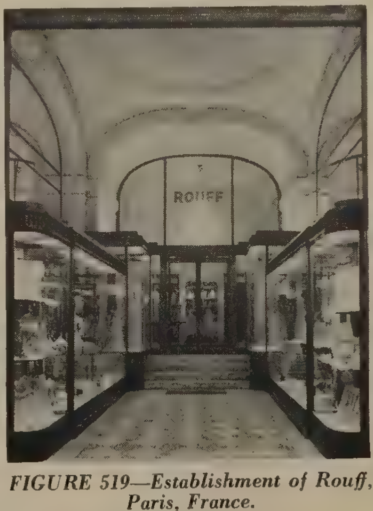


FIGURE 519—Establishment of Rouff, Paris, France.

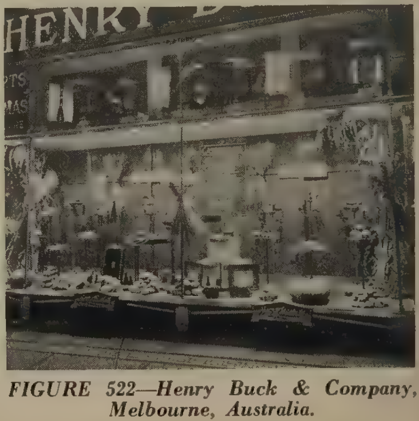


FIGURE 522—Henry Buck & Company, Melbourne, Australia.

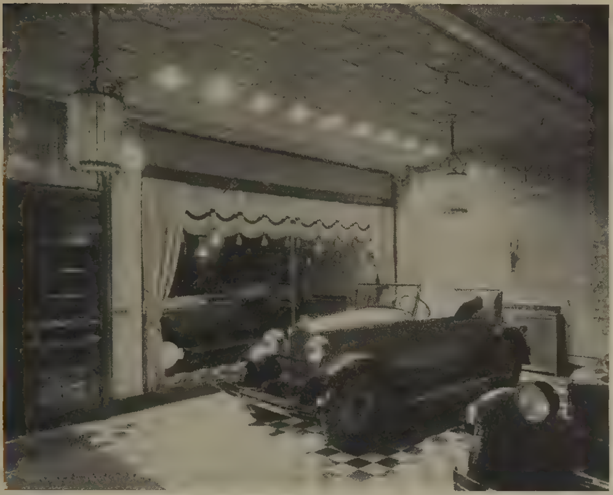


FIGURE 523—The South Side Auto Sales display room, Chicago, Ill. Reflectors for concentrated lighting are hidden above the ceiling.

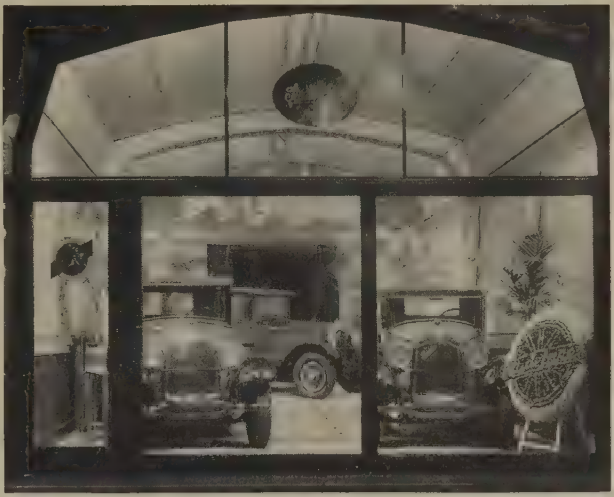


FIGURE 525—Studebaker automobile sales room, Brussels, Belgium. The window lighting contributes to the general illumination of the shop interior.

very useful addition, a typical example of which is shown in Figure 514. The reflector is so designed that it gives a general flood of illumination over the entire display and at the same time concentrates a spot of light upon the particular object to be emphasized. If it is desired that the general flood of light be eliminated, a control ring, as shown on Page 301, is attached by snapping over the lip of the reflector, thus confining the light to one straight controlled beam. This Flood-Ray equipment may also be equipped with the color attachment, which enables the user to obtain beams of green, amber, red, or blue light. Sizes for 200-watt lamps and for 500-watt lamps are available.

The fundamentals which govern the selection of equipment for show window lighting are discussed on pages 296 and 297. The details of the use of color floodlighting and proper spacings of equipment are also taken up in detail. Obviously, high shallow windows are better lighted with a concentrating type of reflector, while a deep spacious window calls for a distributing type.

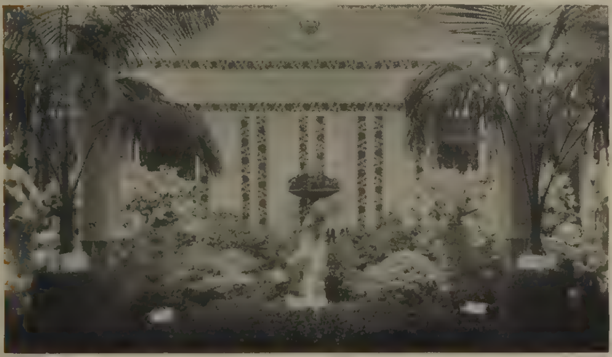


FIGURE 524—Flower Exposition, Pabellon de Las Rosas, Buenos Aires, Argentine.

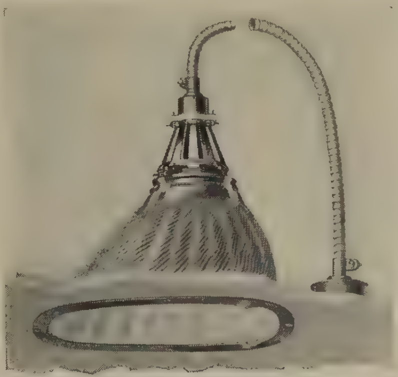


FIGURE 526—X-Ray reflectors are frequently recessed in the ceiling of the show window using metal flanges to finish the opening. See page 300 for further details.

One of the tendencies in modern window lighting is to conceal all the mechanical equipment from view, and for this purpose a cast iron ring, or flange, has been designed as shown in Figure 526. It neatly covers the edge of the hole cut in the ceiling and firmly supports the reflector. The shape of the ceiling flange conforms to the contour of the reflector.

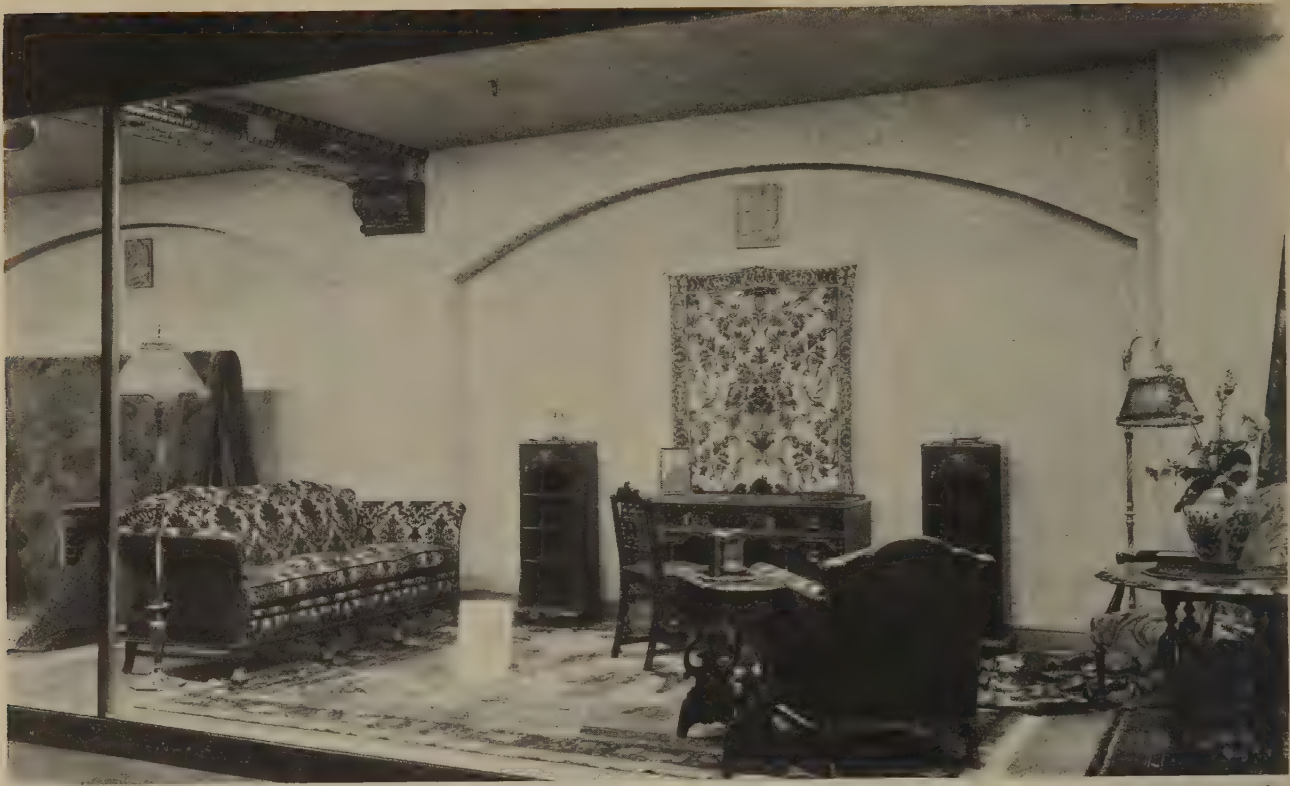


FIGURE 527—The Ensenberger furniture store, Bloomington, Illinois, displays house furnishings in an artistic manner, and equips the show windows with devices that will produce harmonious lighting effects.

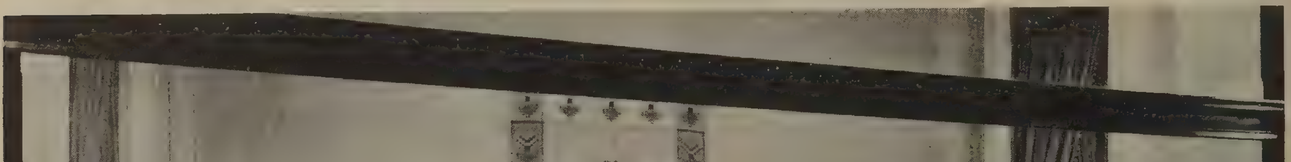


FIGURE 528—A typical display window of the T. Eaton Company, of Toronto, Canada. This famous mercantile establishment utilizes good lighting to emphasize the values offered to the public.

Interesting Examples

Electrical shops and the sales rooms of central stations are leaders in lighting practice. Outstanding examples are to be found in all parts of the country. The entire 250 feet of store frontage of the Union Electric Light and Power Company, of St. Louis, with the exception of the three entrances, is devoted to show windows. These enclosures are 7 feet deep and 9 feet high. The back and sides are finished in an imitation of Italian Travertine. The windows with their carefully planned displays create a buying urge that is always distinctly felt. A considerable quantity of merchandise, particularly portable lamps, has been sold right out of the windows.

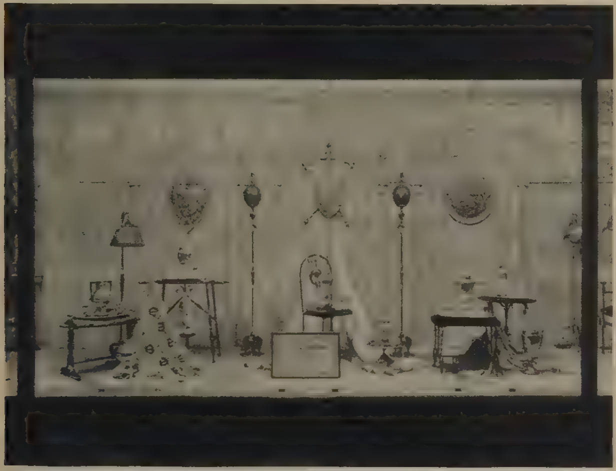


FIGURE 529—Union Electric Light & Power Company, St. Louis, Mo. Effective lighting for the merchandise of an electrical shop.

Large 500-watt X-Ray reflectors are used on approximately 4 foot centers for super-lighting, with the intervening spaces filled with 200-watt reflectors intended for the normal lighting services. The large reflectors are controlled by independent circuits, and the smaller ones are wired alternately on two circuits. Color lighting is obtained by the use of gelatin screens, such as shown on Page 300, installed on the reflectors.

As a supplement to the overhead lighting, a system of disappearing footlights has been provided. The cover of the footlights forms a part of the floor of the window when the equipment is not in use. The mechanism, which is shown in Figure 206, includes mirrored reflectors for 50-watt lamps on 6 inch centers supported by the Curtis Strip channel illustrated on Page 303.

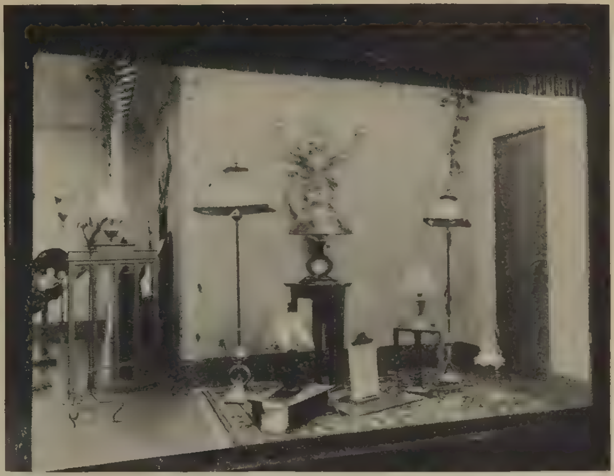


FIGURE 530—Public Service Company of Northern Illinois, Joliet, Illinois. The show windows are equipped with special lighting for the background.

A progressive electrical shop of the modern type is that of the Public Service Company, of Joliet, Illinois. The feature of note is the arrangement of the window lighting which includes all up-to-date innovations. A diagram showing the details of the equipment installed for complete lighting control and maximum effects is shown in Figure 531. In addition to the generous provision of standard lighting and auxiliary illumination for the signs above the display area, the point of particular interest is the arrangement made for background lighting with reflectors of a concentrating nature equipped for tinted lighting.

The Ward Shoe Store on 5th Avenue, New York, was cleverly designed with the express

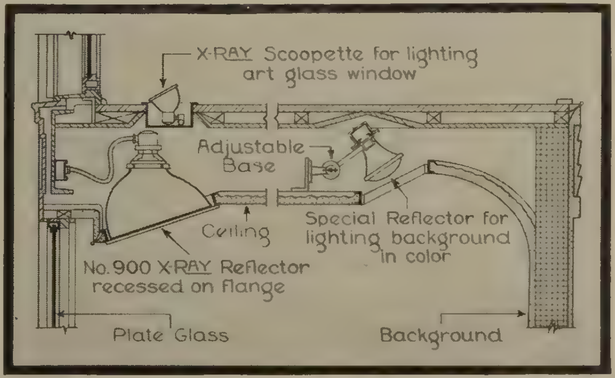

X-RAY Scoopette for lighting art glass window
Adjustable Base
Ceiling
Special Reflector for lighting background in color
No. 900 X-RAY Reflector recessed on flange
Plate Glass
Background

FIGURE 531—Detail showing the complete scheme for the illumination of the display windows of the Public Service Company, Joliet, Illinois.

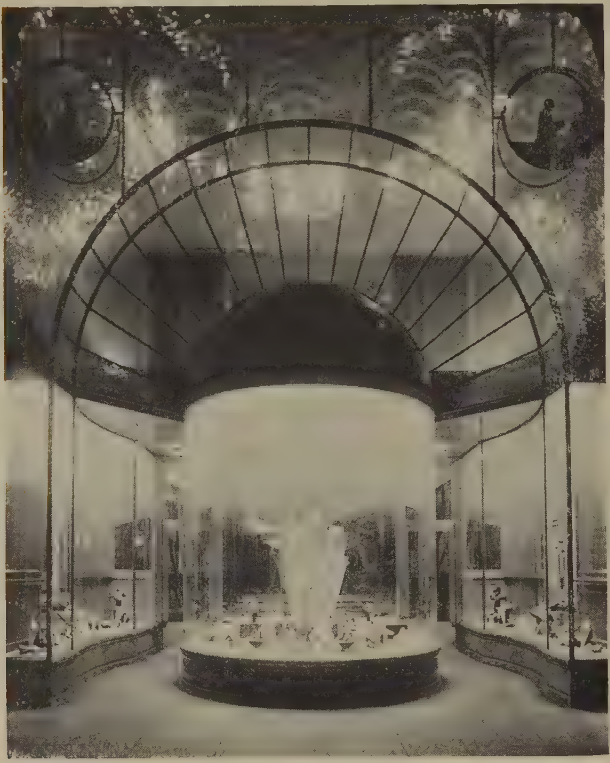


FIGURE 532—*Unique circular window of the John Ward store, New York. Richards, Haviland, Smythe, Architects. Super-lighting makes this window a Fifth Avenue attraction.*

intention of utilizing to the fullest extent the extraordinary attraction powers and attention focusing qualities of light. Its unique circular window, 12 feet in diameter, is capped by a dome finished in dull gold leaf of a mosaic pattern. Back of the glass line is a solid wall and ceiling of mirrored mosaics made of small silvered glasses about $3/4''$ square. Thirty concealed X-Ray reflectors for 60-watt lamps are directed at various angles to give a fascinating effect of sparkle from the tiny mirrors. All standard window lighting equipment for 200 and 500-watt lamps is recessed above the ceiling line. The interior of this store is lighted as described on Page 95.

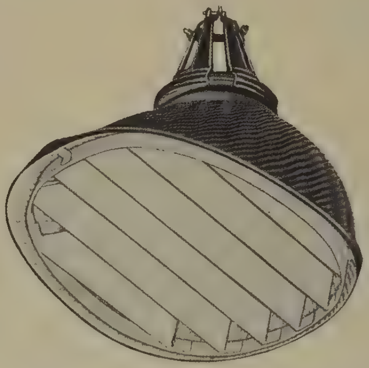


FIGURE 534—*Typical X-Ray show window reflector equipped with a louver to prevent a view of the lamp filament. See also Page 300 for more complete information.*

The show windows of the Palace Department Store, in Spokane, required more than 700 X-Ray reflectors of the style known as No. 510. These island type windows presented an unusual lighting problem, since they are very low and deep. This condition was solved by installing all equipment above the ceiling line in false beams and controlled with louvers and diffusing glass.

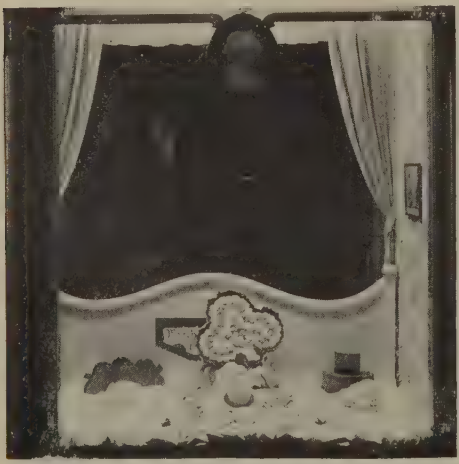


FIGURE 533—*This typical candy shop window is in Kansas City, Mo.*

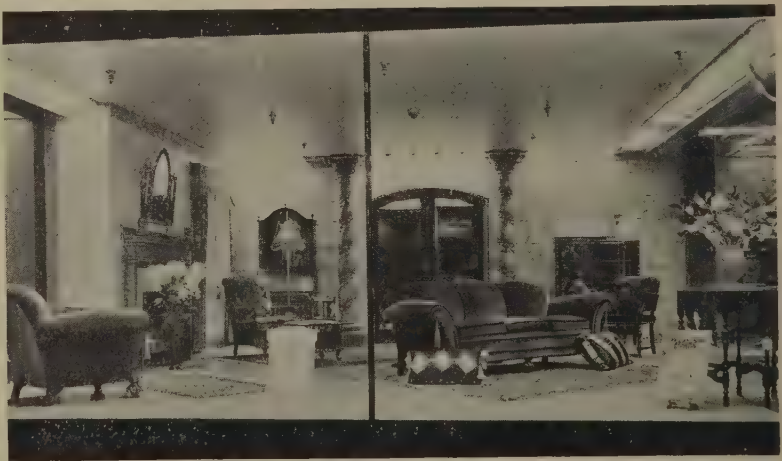


FIGURE 535—*Palace Store, Spokane, Wash. Rigg and Van Tyne, Architects. All lighting is from reflectors above diffusing glass.*

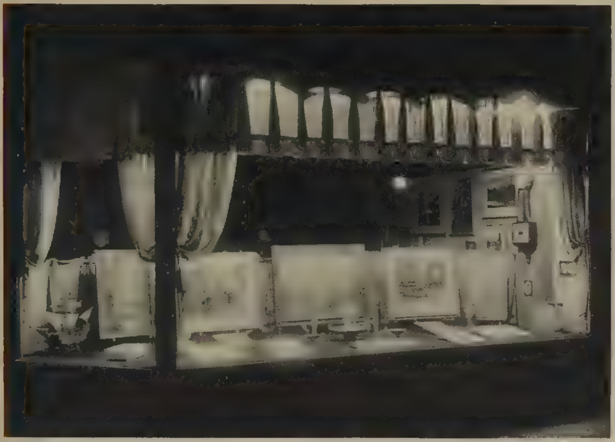


FIGURE 536—Grable Art and Gift Shop, Oak Park, Ill. A show window without background requires concentrated lighting with lamps shielded.

One of the most interesting recent developments in bank publicity is the use of the display window. While window and lobby display advertising constitutes a very direct, efficient, and economical method, its educational value is still to be appreciated by most banks, although many executives are firmly convinced that the time and space devoted to this activity are very profitable.

The bank holds a unique position as compared to the retail shop, regarding what may be done with its window display. In fact, there seems to be an unlimited field with respect to the types of displays and the appeals that may be made to the community, because of the great variety of materials that may be used for exhibits. Architects are providing more space in the new banks for show windows. The problem of illuminating displays in a bank window is very similar to that encountered in a mercantile establishment. The same rules and the same type of equipment may be employed. Frequently light is used in the display itself. Of the best type of window displays in banks today, that shown in Figure 537 is typical.

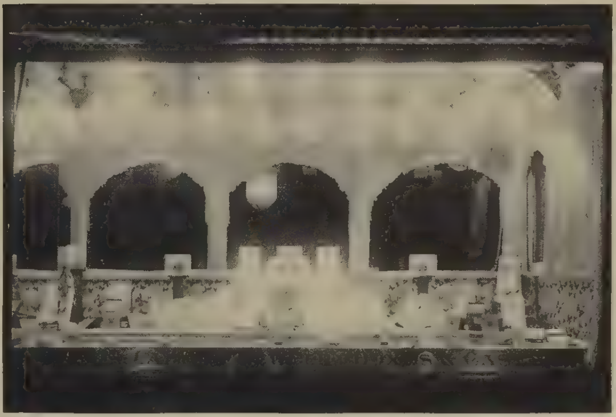


FIGURE 538—Special decorative lighting for display of the Dennison Shop, Chicago, Ill.

Show windows with an open background such as those illustrated in Figures 536 and 538 usually have a low trim and, therefore, require a reflector of the concentrating type, such as shown on page 299, having the front surface extended so as to shield the lamp from view and a contour that will confine the light to the display and prevent losses outside of the window enclosure.

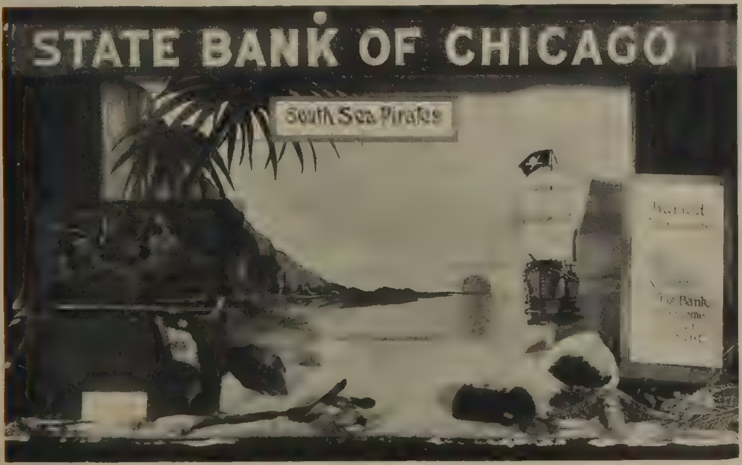


FIGURE 537—A show window of the State Bank, Chicago. Typical of the displays now being used by financial institutions.

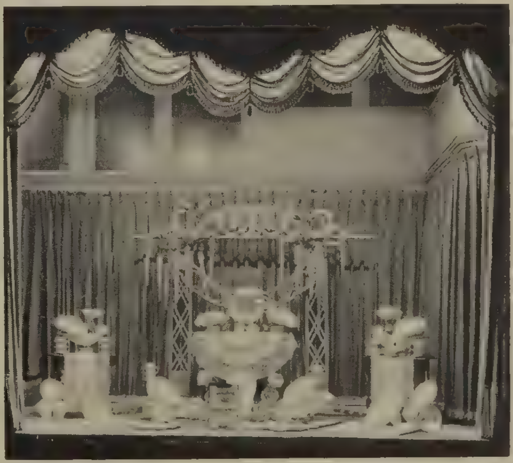


FIGURE 539—One of the display windows of the establishment of Meier & Frank store, Portland, Ore.

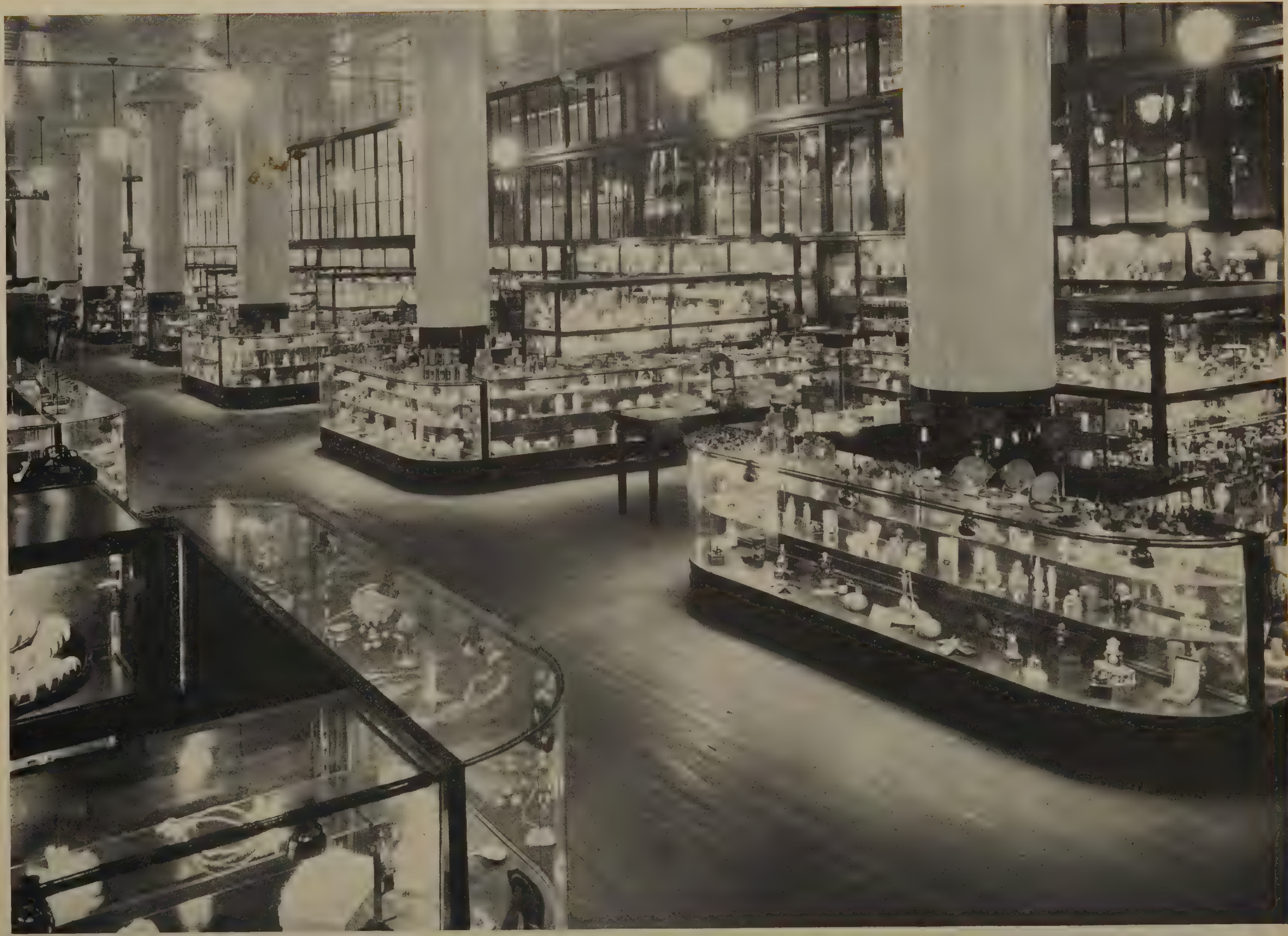
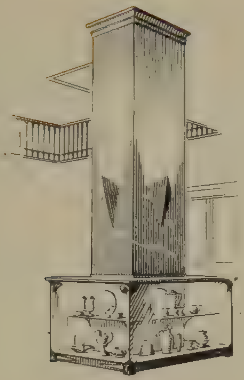


FIGURE 540—Every display case on this sales floor of the Boston Store, Milwaukee, Wis., is provided with lighting equipment. Show case displays are more effective and given greater sales value when made attractive by good lighting.



DISPLAY CASES

MERCHANTS in the good old Colonial days had only counter and wall shelving for display purposes. There were no glass cases. Sales counters were built of solid wood and merchandise displayed on top. The inside was used for storage. The "glass box," or "show case," came into being in the ante-bellum days, and at first consisted of a shallow case which was placed upon the existing wood counter. This case soon developed into a rather pretentious piece of store furniture, constructed with nickel plated frame and hinged drop door. The merchant whose establishment boasted one or two such cases was evidently one of the most progressive.

When the illumination of the interior of the store developed to a point where intensities of several foot-candles were used, it was found that reflections in the glass tops of show cases made it difficult to view displays that were arranged within. It was discovered that artificial lighting could be used to minimize these reflections. Furthermore, since the general adoption of display case illumination other advantages have been found.

There is no question in the mind of the merchant as to the desirability of this type of lighting from the standpoint of attractiveness. Tests reveal that a positive definite buying impetus results from the use of proper lighting, and observation shows a decided improvement in the general appearance of the establishment when cases are illuminated. The display that stands out from its surroundings in a bright light supports the efforts of the salesperson in creating a buying urge.

The cost for display case lighting and maintenance, compared to the cost of the display case, convinces us of the economical basis upon which this form of lighting may now be employed. It is very doubtful if the user would dispense with it, any more than he would with show window lighting, because of the savings that might be made in the cost of current and lamp renewals.

To determine the effect of lighting in display cases upon attraction value and buying incentive,

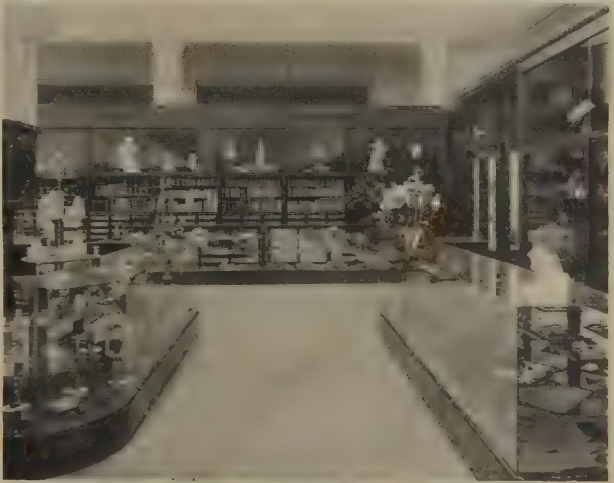


FIGURE 541—The unlighted display case loses much of its value as a means of showing goods to the prospective customer. Reflections from the glass top of the case prevent proper viewing of the contents.

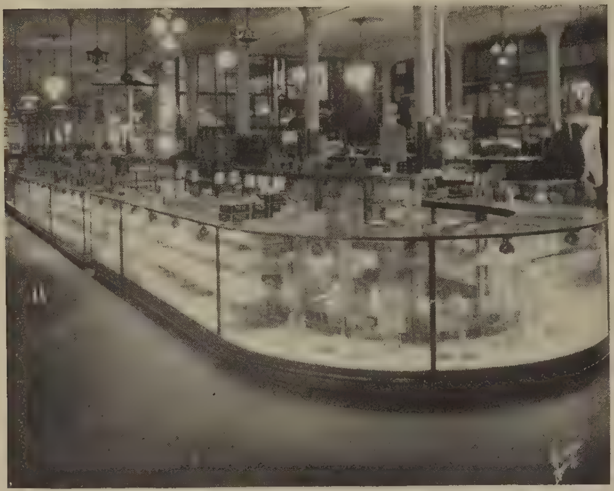


FIGURE 542—Display case in the store of Emery, Bird, Thayer & Co., Kansas City, Mo., showing application of the Scoopette to a display case with curved ends.

a series of tests was recently made. The men's furnishings section in a department store was taken as an appropriate test location. A case, not on the main aisle, was selected because an average amount of traffic passed through the department on the way to elevators and to other departments.

In making the determination, a count was kept of the total number of persons passing through the department, also those were counted who made purchases at the case, stopped to inspect the display, hesitated in their passage through the department, or were otherwise attracted. Investigation included a count with no lights in the case and for various intensities of lighting.

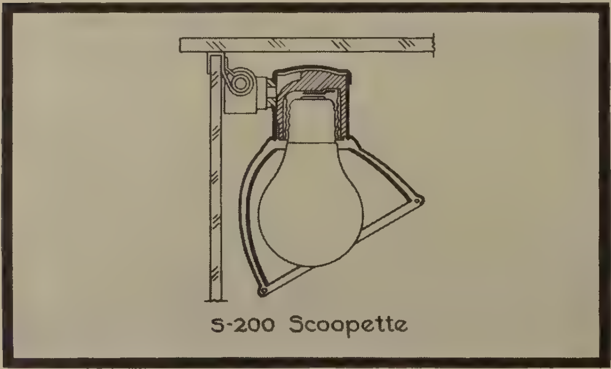


FIGURE 543—A Scoopette unit designed for the proper and sufficient lighting of display cases, with standard base lamps.

The results when analyzed show an increase of 53% in attraction value for 10 foot-candle intensity over no lighting, 50% increase for 35 foot-candles over the 10 foot-candle intensity, and an increase of 130% in attraction value for the 35 foot-candle intensity as compared with the values obtained for the unlighted case.

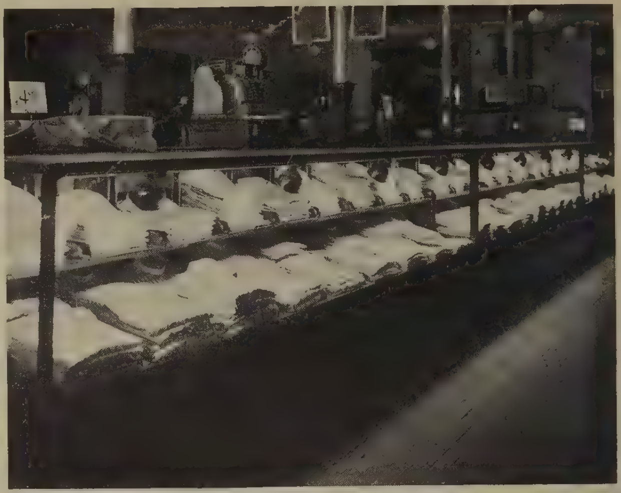


FIGURE 544—A close-up view of a case in Wieboldt's store, Chicago, Ill. Note with what effectiveness the light is confined to the display in the case.

One of the most interesting things in regard to the test was a distinct increase in sales activity during the period of high intensity lighting, when more purchases were made from the particular case under test than during similar periods for the week previous.

The nature of the problem requires that the equipment for display case lighting conforms to

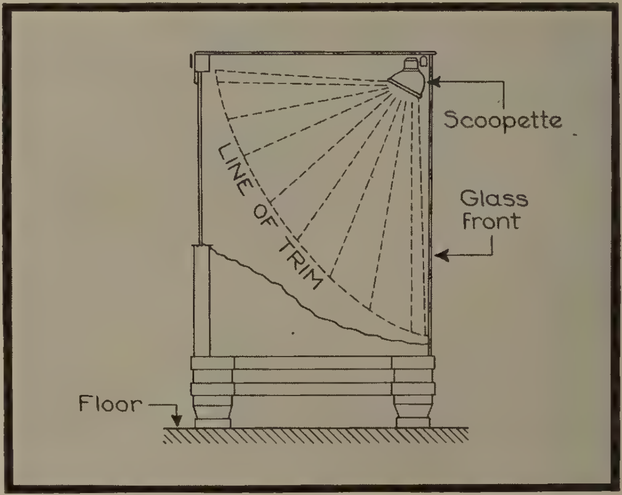


FIGURE 545—Cross section of typical floor display case, showing the proper position for the lighting equipment in the upper front corner.

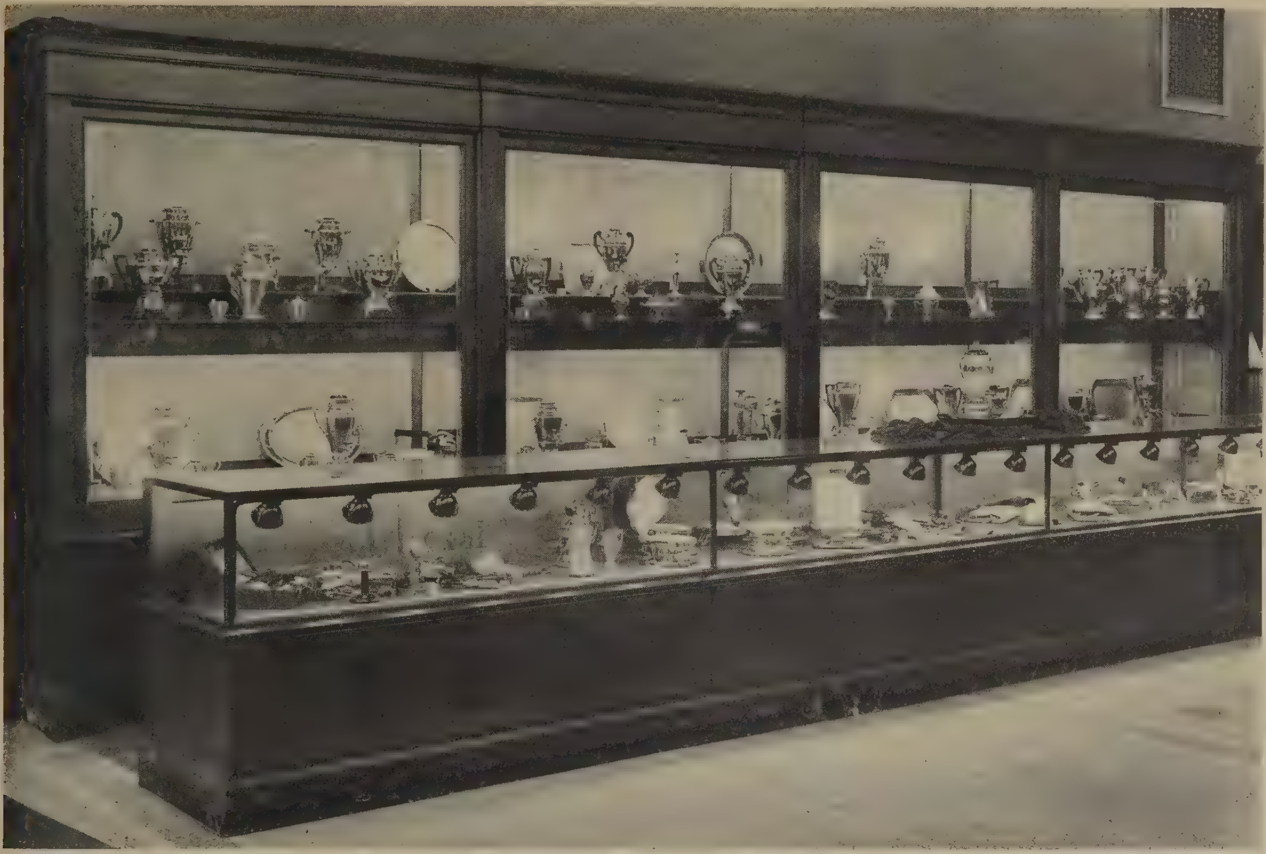


FIGURE 546—A view of the electrical sales room of the Milwaukee Railway and Light Company, Milwaukee, Wis. Both floor cases and wall cabinets are attractively lighted by reflector equipment, with units installed on 12-inch centers.

several very definite essential requirements if the illumination is to be satisfactory to the user.

The general appearance of the equipment when installed in the case must be pleasing in its design and finish, and detract in no way from the general appearance of the case. It should be small in size and neat in appearance.

The lighting results to be obtained from the equipment are of first importance. The unit must properly reflect and distribute the radiance from the lamp evenly throughout the case, permitting no waste light to "spill" from the top or the front. Furthermore, the lamp must be entirely concealed from both the clerk behind the counter and the customer. No matter from what angle the clerk approaches the case, he should not be subjected to fatiguing glare from the exposed lamp.

The expenditure in electrical energy should be as small as possible for best lighting results. This is obtained only by using the most efficient type of reflecting devices. The cost of lamp renewals may be minimized by using those that are easily

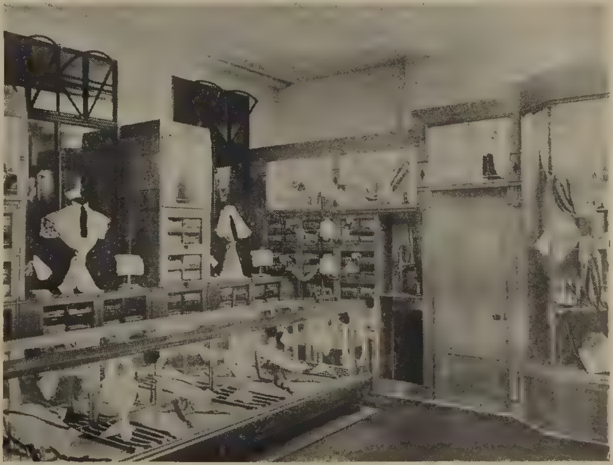


FIGURE 547—A corner in the shop of Austin Reed, Ltd., Leeds, England, installed by British-Thompson-Houston Company, London. Localized lighting in the floor case attracts the prospective customer.

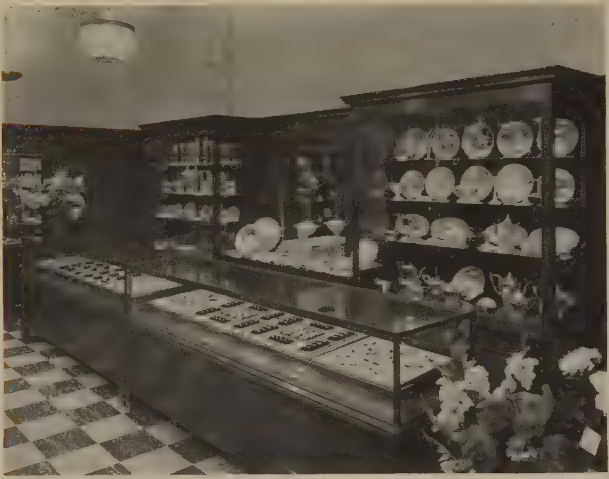


FIGURE 548—*Mealy Jewelry Store, Baltimore, Md., Smith and May, Architects. The display case receives a strong light directed downward from the specially designed luminaire.*

obtainable from the regular source of supply. To insure the longest life of the lamp it should burn in its natural base up position.

The equipment for display case lighting must be of a flexible nature, permitting the use of various lamp sizes. Since different types of display call for distinctly different intensity values, it is advantageous to be able to use lamps of several sizes, as, for example, 15-watt, 25-watt, etc., without making changes in the equipment.

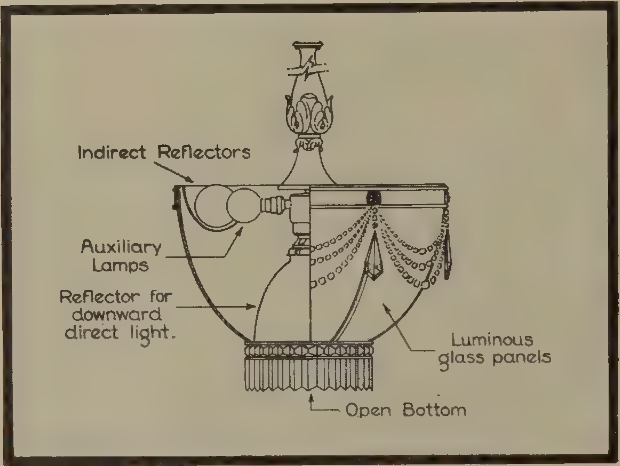


FIGURE 549—*A lighting fixture of special design for jewelry stores and cases and used in the Mealy store shown above.*

As for mechanical make-up, the equipment should be so constructed that it will pass electrical inspection anywhere. The feed wires to the lamps must be enclosed, preferably in small, inconspicuous metal tubes. Obviously the lighting outfit must be made so that it can be installed easily, either in the wood frame case or all glass case without the removal of the top.

A device known as the "Scoopette" has been designed especially to fulfill the requirements outlined above for display case lighting. It has a properly designed reflector, which completely conceals the lamp from the view of the customer and salesman. It confines all of the light to the case interior, is small, neat and inconspicuous.

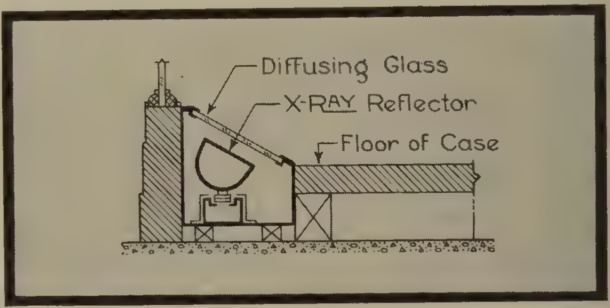


FIGURE 550—*Details of the lighting method used for large display cases of the Bonwit-Teller store.*

The photograph shown in Fig. 540 illustrates the main portion of the Boston Store, in Milwaukee, and shows how the "Scoopette" lighting is fulfilling all of the above requirements in actual practice. The units in these cases are installed on 24-inch centers, with 15, 25, or 50-watt lamps, depending upon the location of the case and the kind of merchandise displayed.

A rather unusual method of treatment, combining general illumination for the store and di-

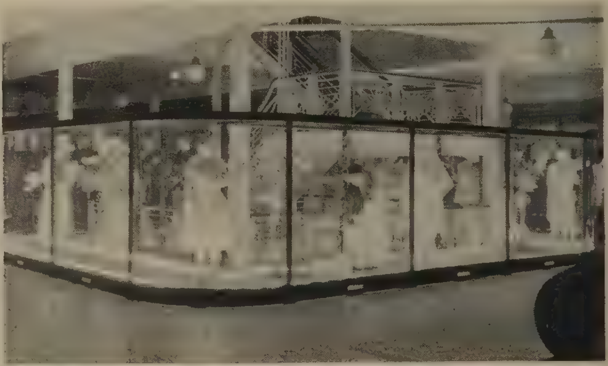


FIGURE 551—*Special display case with unique lighting, Bonwit-Teller Company, Philadelphia, Pa. Note the position of lighting equipment at the bottom of the case to prevent glare into the eyes of patrons ascending the stairway at the right.*

rect lighting for display cases, is shown in Fig. 548. The lamps supplying the general indirect illumination are controlled separately from the lamps that reflect downward upon the cases. A strong illumination is thus provided for the exhibiting of silverware and jewelry to a customer. The downward light penetrates the glass top of the case, brilliantly illuminating its contents.

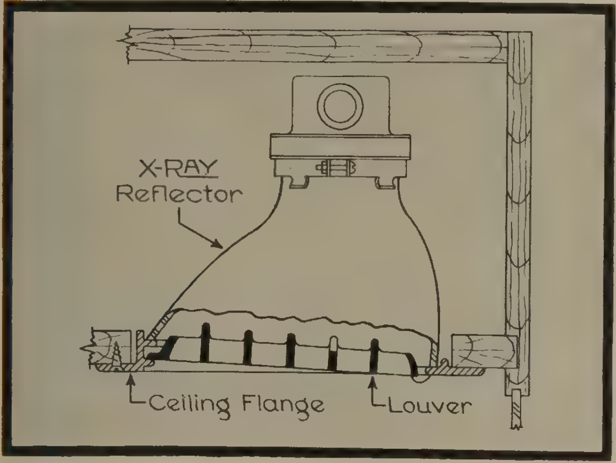


FIGURE 552—Detail of the method used for proper illumination of wall cases.

For the illumination of wall cases the reflected light must be confined to smaller limits, since the cabinets are usually high and shallow in their physical proportions. To meet this requirement reflectors (illustrated in Figs. 552 and 555) have been especially designed. Ordinarily wall cases have a deep cornice or framing behind, which equipment may be satisfactorily concealed.

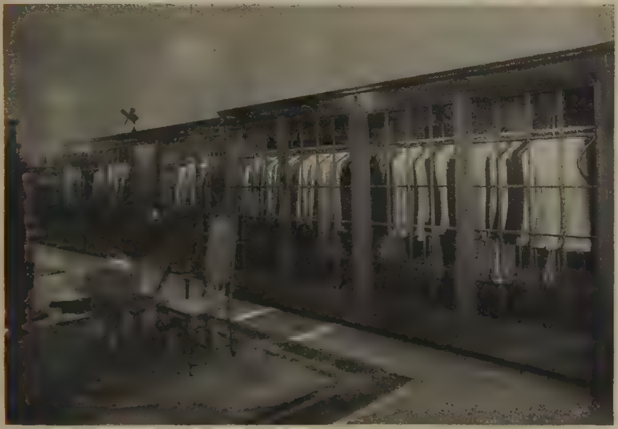


FIGURE 553—Wall cases in a clothing store. E. P. Lewin, Architect, Chicago, Ill. Dark Cases are mere storage cabinets. A customer is enabled to make a selection more readily when the merchandise is illuminated.

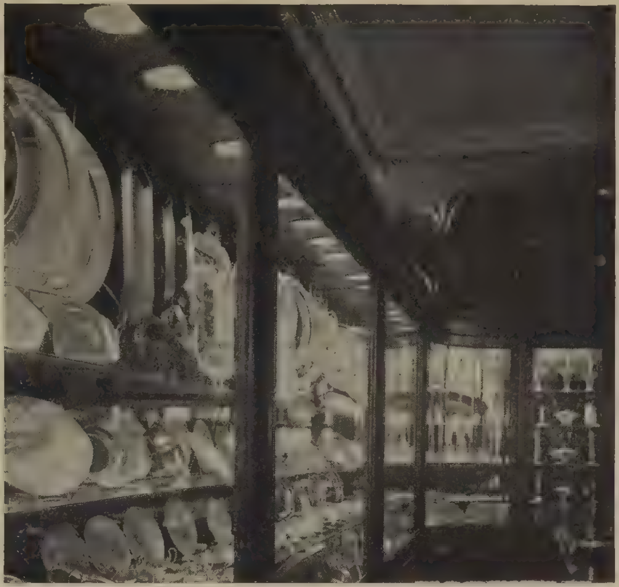


FIGURE 554—Silverware display with concealed lighting. Peacock's jewelry store, Chicago, Ill. The reflector shown in Fig. 522 is used here.

Frequently, as may be noted in Fig. 554, the reflector equipment is installed entirely above the ceiling of the case. The light from the reflector units is projected through an opening. The illustration in Fig. 552 shows clearly the position of the lighting unit, and indicates the method of finishing the opening by means of a cast metal flange. This procedure entirely conceals the mechanical devices that are employed in producing the lighting results, and is a scheme that can be successfully used in instances where it is distinctly undesirable to have lighting equipment protrude below the ceiling line.

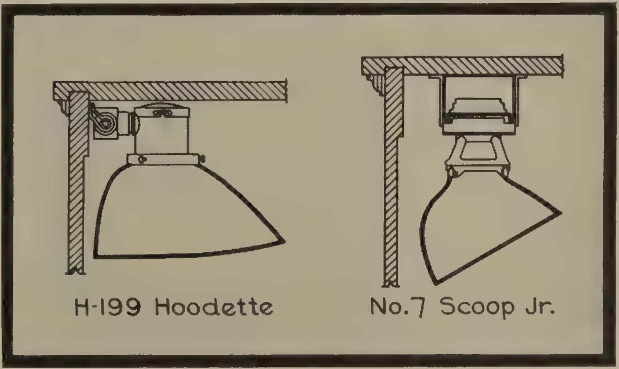


FIGURE 555—Diagram illustrating equipment designed primarily for the lighting of wall cases.

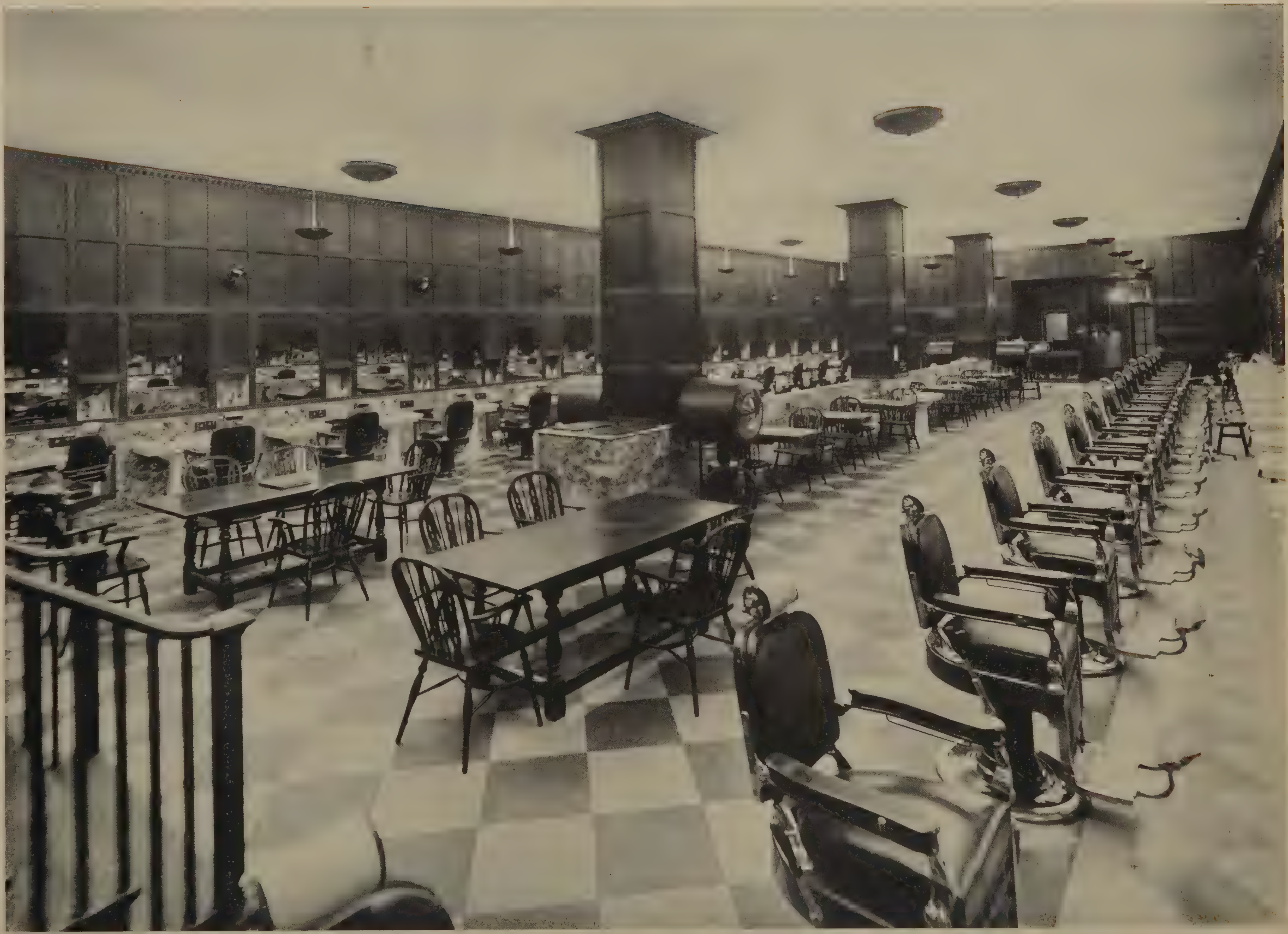
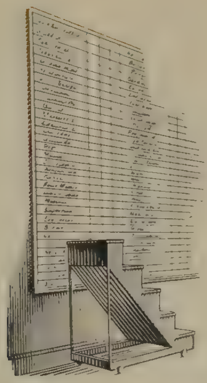


FIGURE 556—The Federal Barber Shop, New York, N. Y. Adequate illumination for all the shop services and restful lighting for patrons is provided by the shallow bowl indirect luminaire.



MISCELLANEOUS

AT THE outset it was stated that many applications of modern artificial illumination could not be pictured or discussed in a volume so limited in proportions. Many which come within the range of everyday experience are difficult to classify under the headings selected for the preceding pages. From the category of the miscellaneous in our varied lighting experience a few unrelated examples have been selected for this chapter of the book. They may be helpful in suggesting the unlimited possibilities in the use of light; light to improve our working efficiency, light as a decorative medium, light as an aid in making sales, light as a symbol, light for our comfort; in fact, for any use. Regardless of the purpose for which it may be utilized, light is susceptible to thoroughly fitting and harmonious application.

An interesting method for barber shop illumination is shown on the opposite page. The bright lights are concealed, and a cheerful, inviting atmosphere prevails. There are no glaring sources to cause restlessness and irritation. The lighting is restful and adequate, purely of an indirect type, and is provided by means of a simple but artistic luminaire.

A most unusual scheme of illumination is employed in the Rapp's Barber Shop, of Youngstown, Ohio, an up-to-date and well equipped establishment. A simple pedestal of the indirect lighting type is made up utilizing a pipe standard on which is mounted a metal bowl ordinarily utilized as an indirect lighting fixture. This adaptation is unique, inasmuch as it also incorporates a series of hangers for coats and hats of the patrons of the shop. These hangers, it may be noted, are just below the lighting bowl. Thus the lighting equipment serves a double purpose. Very agreeable results are obtained by using three 150-watt lamps in each pedestal. The lighting standards are spaced about 10 feet apart and disposed in a single line down the middle of the room. Electrical outlets in the floor just below each pedestal supply the source for energy. The reflectors in the bowl are so designed as to give a wide spread of illumination over the ceiling, giving it a uniform brightness. The use of any suspended fixtures

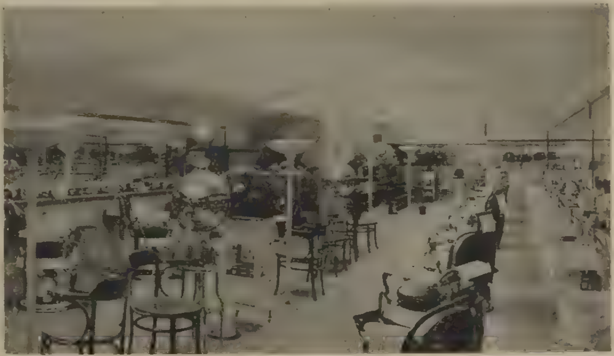


FIGURE 557—Rapp's Barber Shop, Youngstown, Ohio. A special lighting pedestal houses the general illumination equipment and supports hangers for wearing apparel.

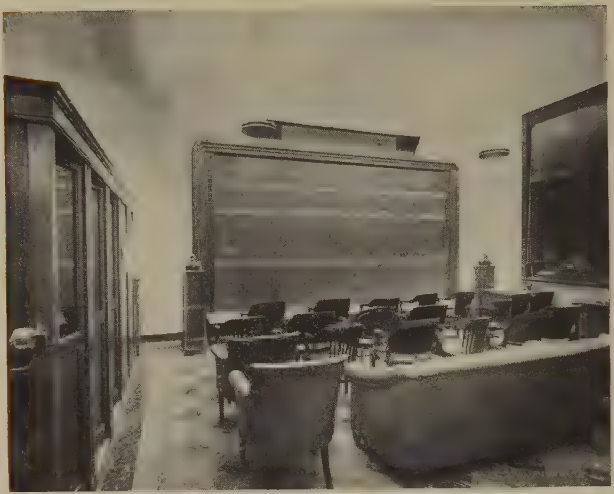


FIGURE 558—The stock quotation board of de Saint Phalle & Company, New York, N. Y. Equipment for lighting the board is recessed above the ceiling in a shallow trough.

would give unsatisfactory results from the standpoint of appearance, and tend to reduce the apparent height of the ceiling.

Stock Quotation Boards

In brokers' offices which contain stock quotation boards very careful provision should be made for illumination. The blackboard, with white and colored chalk marks, forms a maximum contrast in values, as far as the eye is concerned; but the quotations cannot be properly and quickly read if the lighting of the board is not satisfactory. Many methods have been employed in the past, but recent experience has shown that only those that employ concealed lighting equipment are acceptable to the managers of brokerage houses. The system using a simple metal trough of light at the ceiling gives an uneven result, with the top of the board lighted much more brightly than the bottom. By the selection of proper reflector equipment, however, placed in a scientific manner, this strong contrast in lighting is avoided. The secret of even illumination is in the correct re-direction.

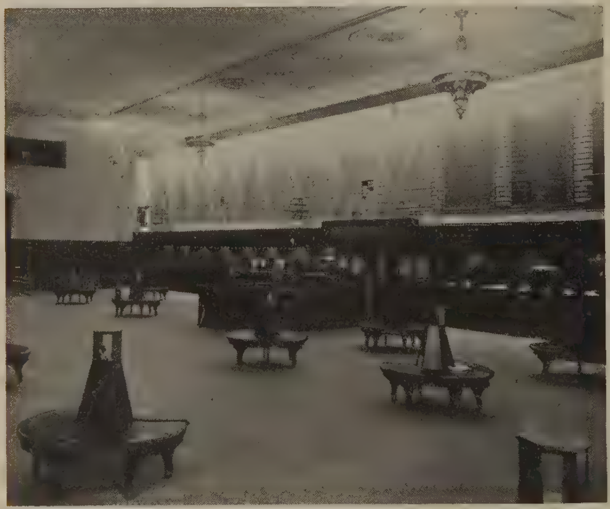


FIGURE 559—The main board of the Chicago Stock Exchange illuminated by reflectors designed for proper light control; a detail is shown in the adjacent diagram.

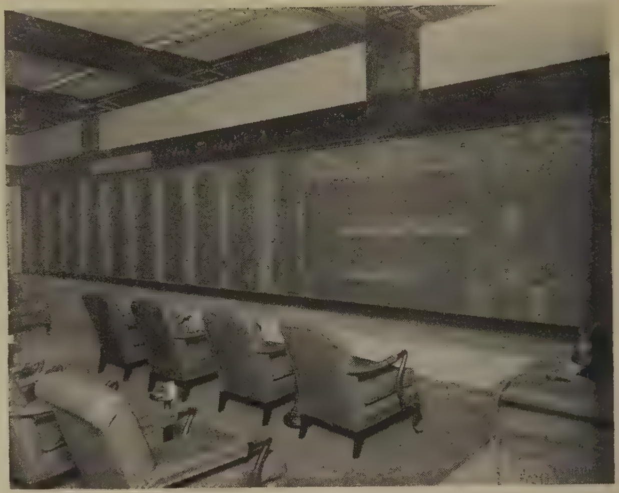
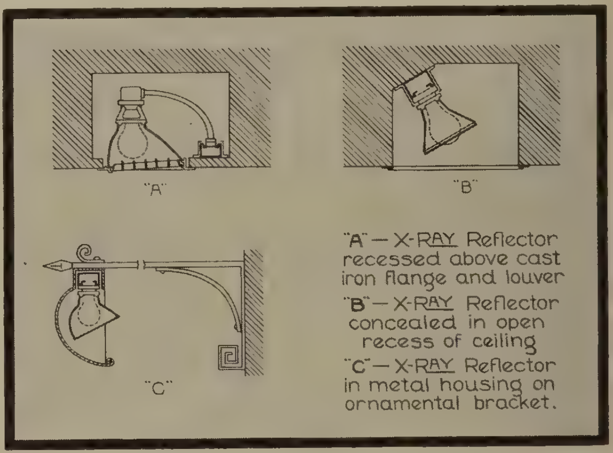


FIGURE 560—E. A. Pierce & Company stock board, Memphis, Tenn. Jones and Furbringer, Architects. Even, glareless lighting by reflectors hidden in a shallow beam.



"A"
"B"
"C"
"A"—X-RAY Reflector recessed above cast iron flange and louver
"B"—X-RAY Reflector concealed in open recess of ceiling
"C"—X-RAY Reflector in metal housing on ornamental bracket.

FIGURE 561—Details of the methods for lighting the stock quotation board shown on this page.

Three interesting examples are here illustrated. Each board is illuminated by a totally different method. In all cases, however, the lamps are entirely hidden from view, and means have been

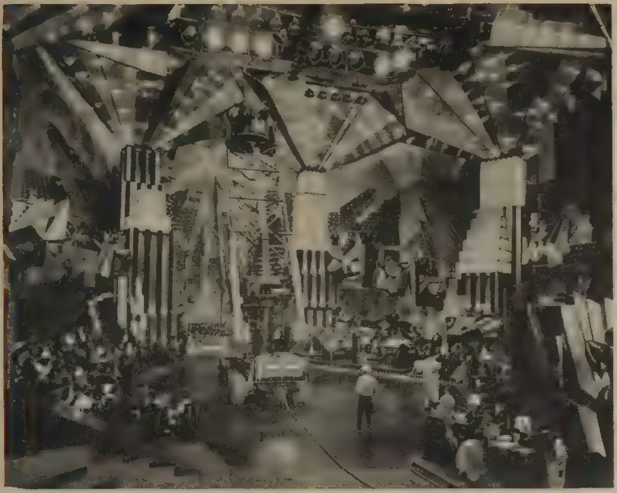


FIGURE 562—An incident in the making of Universal's super-picture "Broadway," illustrating the means employed for the lighting, using a large number of special X-Ray reflectors.

provided for effectively shielding the brilliant lamp filament from the eyes of the customers. Details of the lighting of these three examples are given diagramatically in Fig. 561. It will be noted that in one case the lighting equipment is concealed in a special recess in the ceiling. In another case the reflectors are mounted above the ceiling line, casting their light through openings which are finished with a cast metal rim. The third example utilizes a series of reflectors mounted on brackets projecting from the surface of the board and enclosed from view by an ornamental housing of metal. In all cases the reflectors used are of such design as to give uniform lighting over the entire surface of the board.

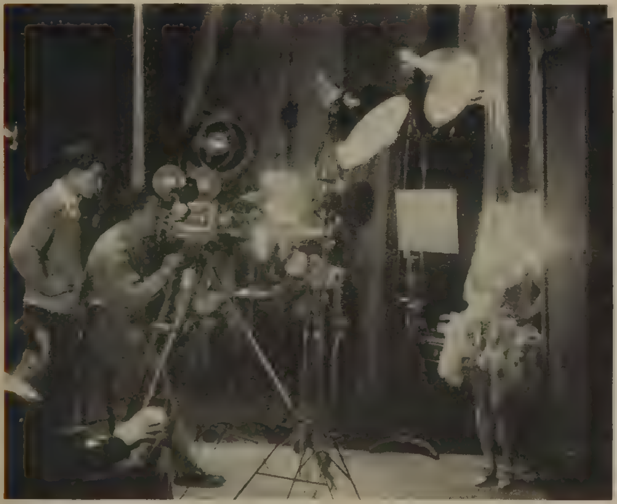


FIGURE 563—Close-up of Evelyn Brent in a scene from "Broadway." Carl Laemmle, Jr., Producer, Dr. Fegos, Director. Special lighting equipment with X-Ray reflectors by Mole-Richardson.

Photograph Studios

The picture shown above illustrates one corner of a huge motion picture "set" used by the universal Pictures Corporation, of California, in filming their new picture "Broadway." The interior is to represent a New York night club done in extreme modernistic fashion. The lighting is accomplished almost entirely from overhead, as shown in the picture, and is accomplished entirely by the use of incandescent lamps. To date this is the largest lighting attempt with incandescent units in the studios at Hollywood. A great quantity of X-Ray units was utilized in the finishing of this picture. The magnitude of the operation may be imagined when it is considered that the total wattage utilized for the set was 4,070,000 units for a total floor area of about 10,000 square feet. The motion pictures were taken with the photograph apparatus mounted on the platform of a specially built truck frame, which could swing the cameras quickly to any height or position.

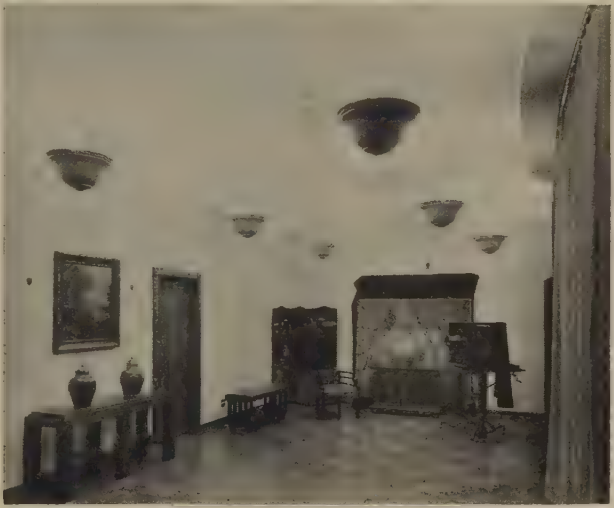


FIGURE 564—Ashley Crippen Studio, Toronto, Canada. Indirect lighting of high intensity.

Another illustration of the same scene pictures a "close-up" of the star, Evelyn Brent. Large X-Ray reflectors, mounted on standards above the head of the actress, furnish the illumination.

In contrast with the strong direct lighting employed for the making of the motion picture, we have an illustration in Fig. 564 of a commercial studio using high intensity indirect lighting. With the extreme intensities necessary for sharp and accurate photograph work, it is necessary to conceal the brilliant lamp filament. When we consider that 1000-watt and 1500-watt lamps are frequently utilized by the photographer, the necessity for the use of indirect lighting is emphasized. With a general lighting scheme, such as illustrated in this studio, the photographer frequently uses supplementary direct side lights for certain directional effects; but these need not be of strong intensity when used with the system of diffused illumination, just sufficient for the degree of modeling that might be desired by the artist.

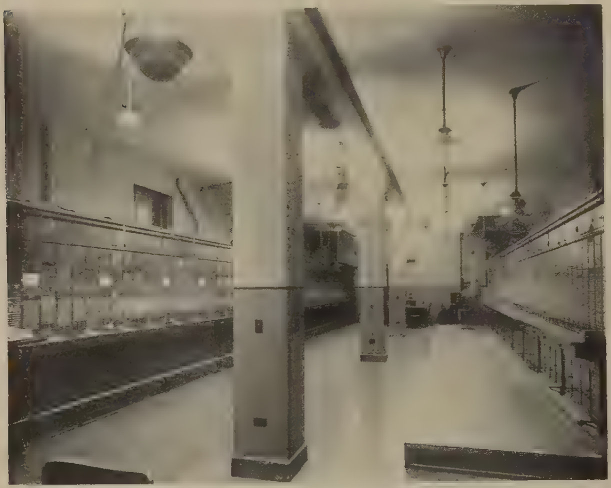


FIGURE 565—Telephone exchange using the indirect lighting system, with simple direct system for emergency purposes.

Telephone Exchanges

In the lighting of telephone exchanges we have the problem of the operating room, of the switching or rack room, and the recreation and rest rooms, in addition to the offices, which are treated in the same manner as general commercial offices. In the manual operating room the paramount requirement for lighting includes sufficient intensity of the proper quality. The lighting should be diffused so that there is no direct glare from the fixtures, and particularly so that there is no reflected glare from the switchboard or other polished surfaces. These requirements are very essential because the efficiency of the operator depends, to a great degree, upon the conditions under which she must work. It is a well recognized fact that either insufficient light or glare causes nervousness and strain, irritability and errors, all of which must be eliminated as far as possible.

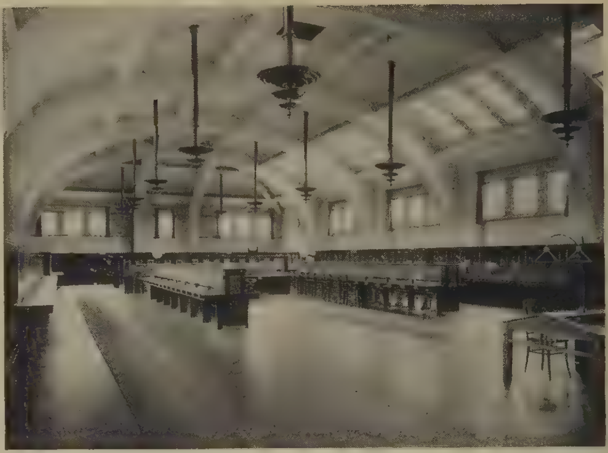


FIGURE 566—Daylight view of telephone exchange, Gothenborg, Sweden. Unique fixture incorporating lighting and ventilating features.

Indirect lighting installed as shown in Fig. 565

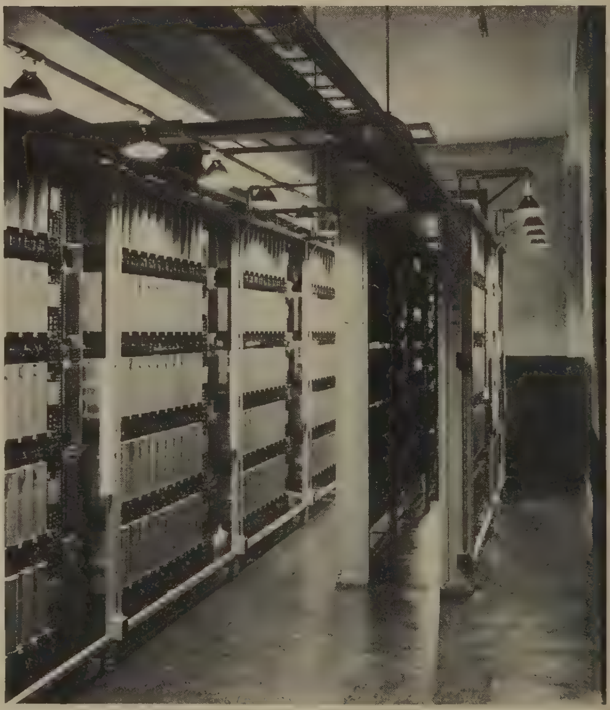


FIGURE 567—Cable racks of telephone exchange, Minneapolis, Minn., using direct lighting with X-Ray reflectors.

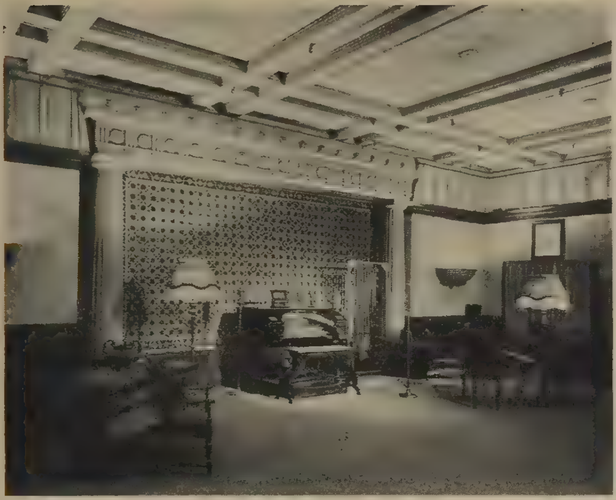


FIGURE 568—Broadcasting station of Station KPO, San Francisco, California. The Curtis indirect portable lamp provides proper lighting and a decorative touch.

is the nearest approach to daylight in quality, and has been found most satisfactory for meeting the requirements of this service. With the indirect luminaire all of the light is first reflected to the ceiling and then diffused throughout the room in a flood of uniform, comfortable illumination. All of the control boards receive an equal intensity of well diffused light. No local lighting is required.

A unique system of lighting is shown in Fig. 566, the telephone exchange in Gothenborg, Sweden, which combines a ventilating system with the lighting. The fixture is suspended from the ceiling by means of a large rod hanger, containing a duct for the passage of air. There are three separate sections to the bottom of the fixture. The upper and largest section forms a receptacle for X-Ray indirect lighting reflectors that provide the general illumination. Through the lower section warm or cold air is blown down into the room.

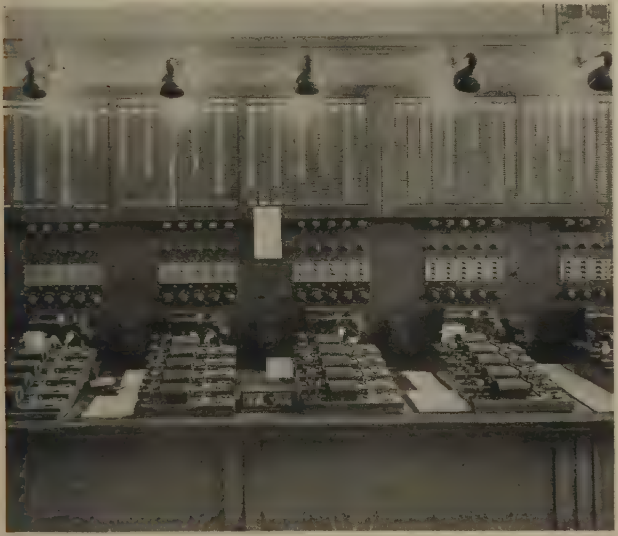


FIGURE 569—Instrument and fire alarm department, City of Chicago. Special lighting with adaptation of the Scoopette reflector.

For the exacting work of the telephone exchange efficient lighting is absolutely essential. Proper light control in the rack room is especially important. The arangement of X-Ray reflectors shown in Fig. 567 has been adopted as standard after considerable research by one of the large telephone companies. The bottom of the reflector is 7½ feet from the floor, and uses a 50-watt lamp. With the units spaced about 4½ feet apart, uniform lighting is obtained on all parts of the rack, and repairs are made without difficulty as far as the lighting is concerned. The strong directed lighting penetrates the intricate mechanism of the rack, enabling the operator to detect any breakage or flaws in the equipment that might be causing trouble in the service.

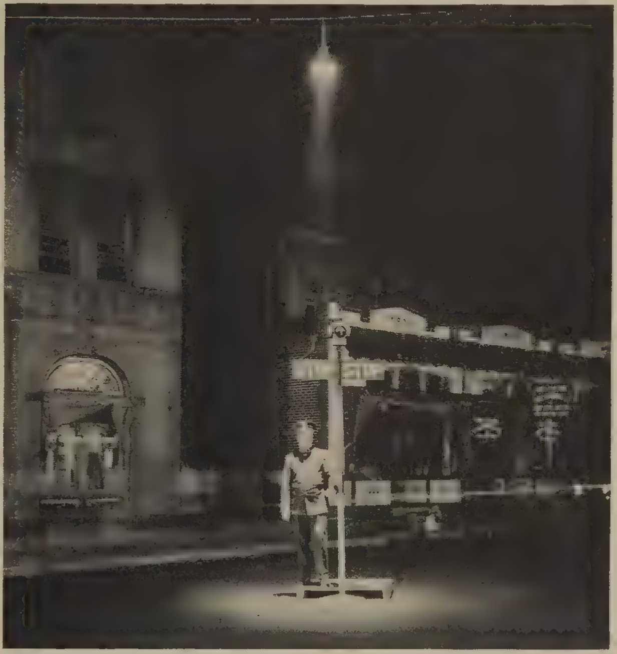


FIGURE 570—Special adaptation of X-Ray floodlighting projector for the lighting of a traffic officer at busy street intersections.

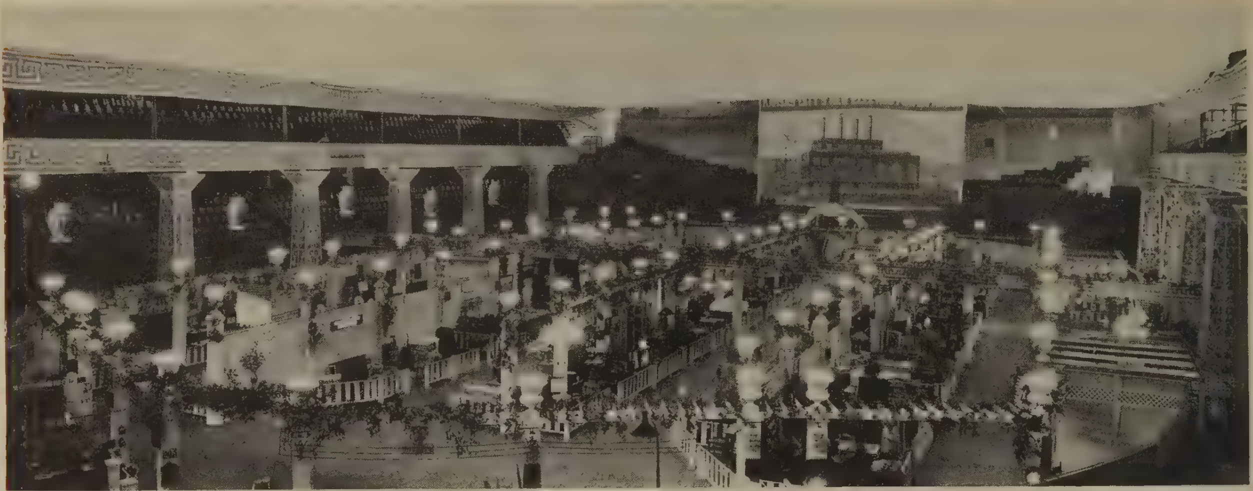


FIGURE 571—Photograph of Convention Hall at Kansas City, Mo., illuminated from reflectors concealed in urns on top of the pillars dividing the booths. No light sources are seen from the floor of the hall.

The lighting problem encountered in the radio broadcasting studio has given the managers much concern. Because of the fact that the studio must be designed very carefully from an acoustical standpoint, it is frequently impossible to use the ceiling for suspension of lighting fixtures. Reflected vibrations and sounds interfere very definitely with proper broadcasting. It has, therefore, been found that indirect floor lamps or table lamps, such as illustrated in Fig. 568, are a most happy solution to the lighting problem of the studio. They can be used for decorative purposes, and at the same time be the means of furnishing general illumination for the room. In the example shown supplementary lighting is provided by wall boxes containing X-Ray reflectors.

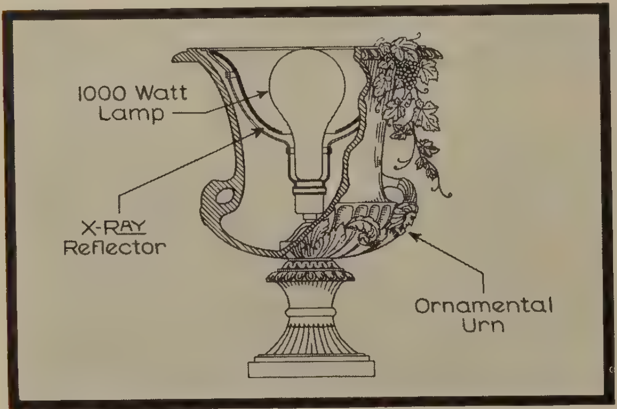


FIGURE 572—Detail of the urn containing the X-Ray reflectors for lighting Convention Hall.

The reproduction in Fig. 569 shows the lighting results obtained from a small bracket type of unit utilizing the X-Ray Scoopette. The installation was made on a signal panel for the fire alarm system in the city of Chicago. Note the extreme uniformity of illumination and absence of shadows. In other words, a perfect lighting is provided for this important department. The bracket, finished in attractive black nickel, extends about 12 inches from the wall, and is supported by a small cast flange only about 2 inches in diameter. A swivel adjustment is also provided for the bracket, making it possible to adjust the angle of the direction of light so that it will properly illuminate the vertical and horizontal surfaces and still shield the eyes of the operator.

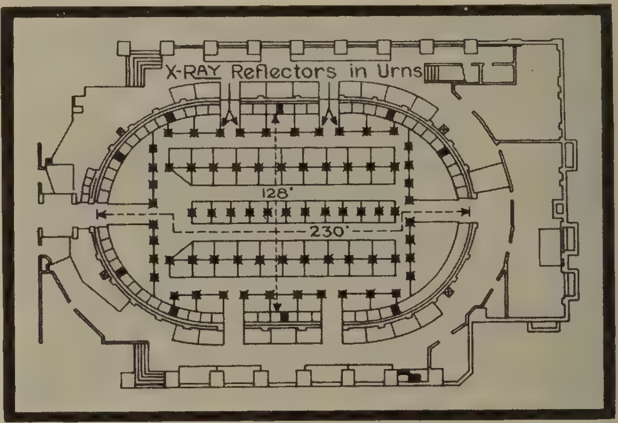


FIGURE 573—Floor plan showing location of eighty 1000-watt units for the lighting of the Convention Hall.

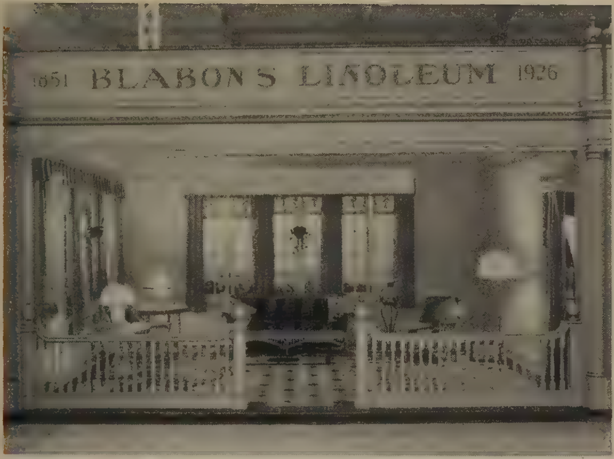


FIGURE 574—Rest room in Liberal Arts and Manufacturers Exposition Building, Sesqui-Centennial, Philadelphia, Pa., lighted with Curtis indirect lamps. Light through the false windows is reflected from a painted background.

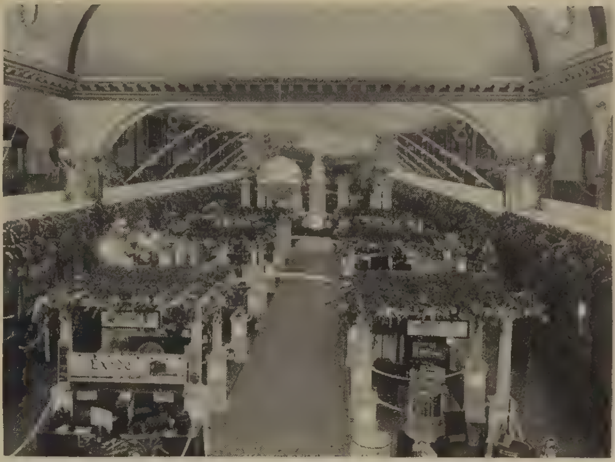


FIGURE 576—Exposition of the Metropolitan Edison Company, Reading, Pa. Special Lighting trough at sides of the room supplies a liberal amount of indirect illumination, conserving the seeing comfort for interested visitors.

At some of the most important intersections of our city streets, where the traffic is particularly heavy, means are provided for spotlighting the officer, who at best has a difficult task in controlling the operations at his corner. The lighting device shown in Fig. 570 consists primarily of a standard X-Ray projector suspended twenty or more feet above the street on a guy wire, or mounted on a street post by means of a gooseneck bracket. By using a standard 200-watt lamp a bright spot about six feet in diameter is cast upon the ground, making the officer and his signal clearly visible at night for a distance of more than a thousand feet.

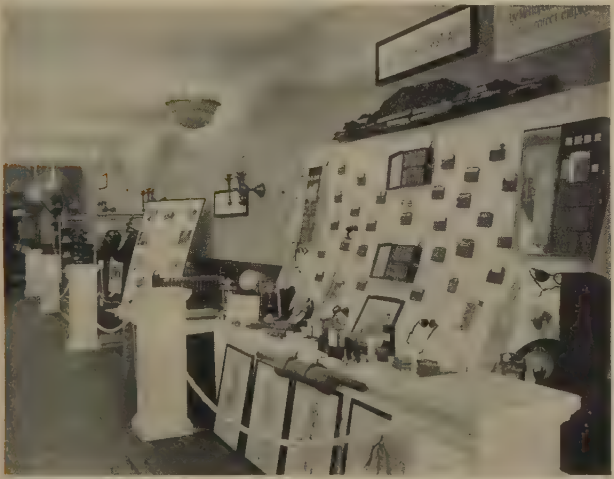


FIGURE 575—Safety exhibit illuminated without glare and annoying shadows by indirect lighting fixtures.

Expositions

At any electrical show or convention there is generally some one thing that the committee wishes to make stand out as a feature. The sponsors of the first electrical exhibition at Kansas City felt that the special lighting of the entire auditorium would be an innovation. They also believed that the illumination features for an electric show should represent the best ideas in this art. The committee therefore adopted a scheme that had previously not been attempted.

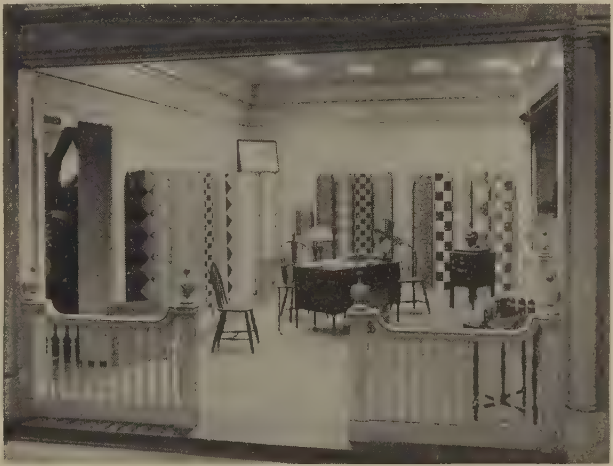


FIGURE 577—Blabon's linoleum booth, Sesqui-Centennial, Philadelphia. Exhibit illuminated from reflectors recessed in the ceiling.

The illumination of a room where conditions are favorable without ceiling fixtures is not complicated in comparison with the problem that was encountered here. The hall is 130 feet wide, 230 feet long, and has a trussed roof without center supports. After some study it was decided to light the auditorium with X-Ray reflectors concealed in ornamental urns, as shown in Fig. 572. The urns were placed on the tops of pillars dividing the booths and used as a decorative feature. Vines and flowers were draped from the sides to conceal their real purpose as lighting standards. The illusion was complete for those attending the show, as the source of lighting was not apparent. The roof of the convention hall was, of course, not suitable for the purpose of indirect lighting, therefore a white canvas was stretched tightly across the entire space, and provided an ideal surface for the reflection of the light. The result was a particularly unique lighting effect for this trade show. An intensity of about 16 foot-candles was obtained and seeing conditions were most comfortable for those attending the exposition.

The principle carried out here can be utilized in many similar cases. The lighting of large convention halls and auditoriums need not be glaring, even though the intensity is high. An application of methods utilized in offices, schools, churches, etc., can be made, even though the use is temporary, such as indicated here. The floor plan of the convention hall is shown in Fig. 573, and indicates that eighty 1000-watt X-Ray reflector units were utilized for lighting this large area of approximately 30,000 square feet. The distance from the floor to the canvas ceiling was 35 feet.

The significant progress made in the field of illumination the past few years was emphatically demonstrated at the recent Sesqui-Centennial Exposition in Philadelphia. The principles of best modern lighting practice were given adequate illustration in the gorgeous lighting effects and in the illumination of the various exhibits. Many examples of cove lighting, indirect illumination from fixtures and by other means, floodlighting, etc., were skillfully presented in this exhibition.

The illustration No. 574 pictures a portion of linoleum exhibit in the Liberal Arts and Manufacturers Building, planned by G. Gerald Evans, interior decorator of Philadelphia. This space has a combination of lighting effects. Curtis indirect portable lamps, such as illustrated and described on page 201, are used for the general lighting, supplemented by false windows, the background of which is illuminated by small X-Ray reflectors equipped with daylight lamps. The illusion of these false windows adds variety and a note of cheerfulness to the space, and is an idea that may be utilized in many other places, as, for example, art galleries, shops, offices which have inadequate daylighting, and basement sales rooms.

Another section of the linoleum exhibit is shown in Fig. 577. Here the lighting equipment is concealed above the ceiling line, having the units disposed with reference to the arrangement of the exhibit, in two lines parallel to the walls of the room and at a uniform distance from the wall line. A very strong concentrated light is cast over the display, and the lamps are shielded from view by means of a specially designed louvre fitted into the ceiling opening.

A system of indirect lighting that gives the same effect as for the Kansas City Convention Hall was adopted by the Metropolitan Edison Company, of Reading, Pa., for its electrical show. Since the room was somewhat smaller in proportions and had a ceiling of suitable reflection quantity, a very clever scheme of lighting was installed along the side walls, with reflectors embedded in an improvised troughing which formed a part of the decorative scheme of the room. The position of the reflectors is clearly shown in illustration No. 576. For smaller rooms and lower ceilinged areas a commercial type of indirect lighting fixture was suspended, as shown in Fig. 575, giving perfect lighting results.

PART FIVE

PLANNING LIGHTING SYSTEMS

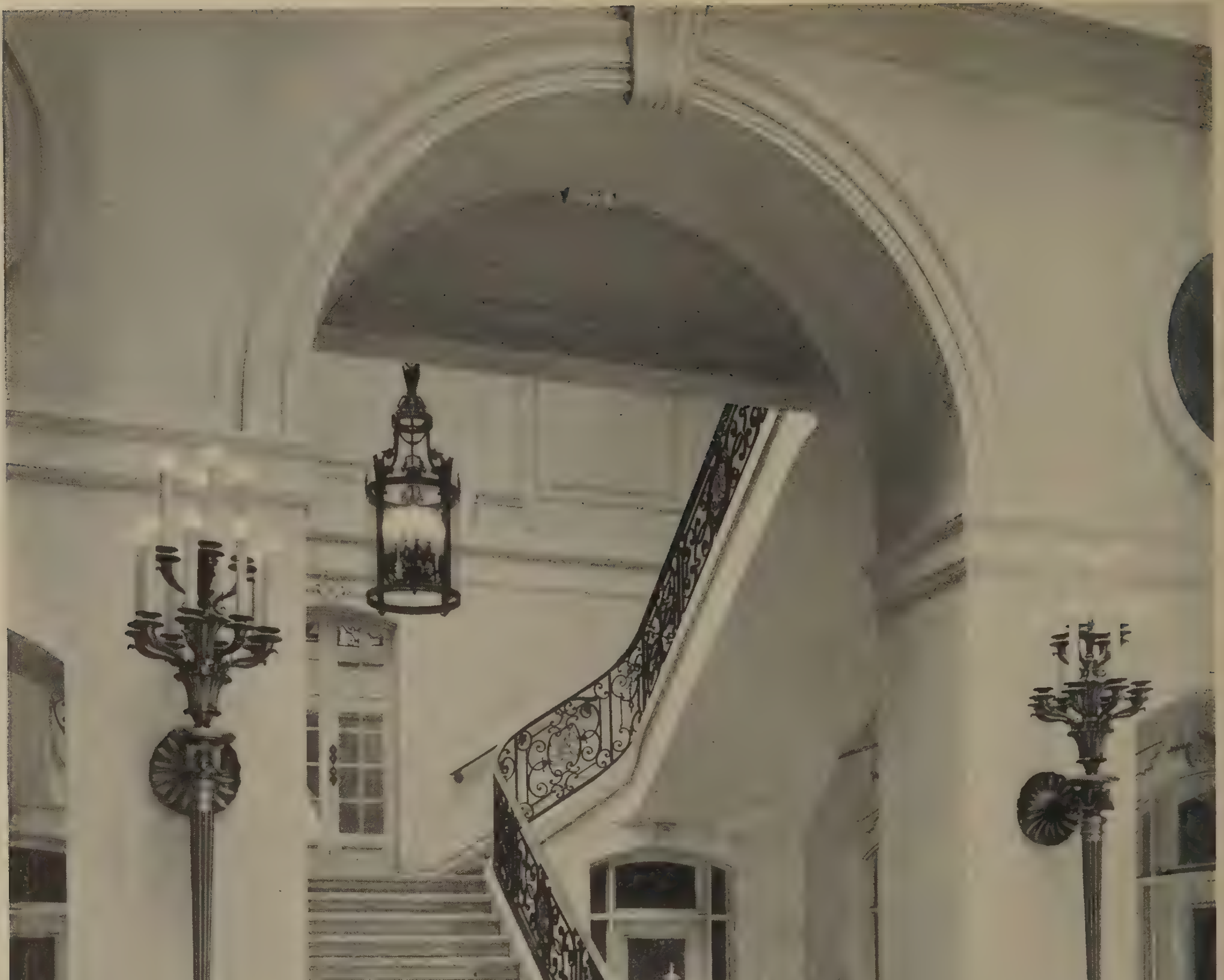


FIGURE 578—View from main lobby toward stair hall in Illinois Life Insurance Company, Chicago, Illinois. Architects, Holabird and Roche. The special candle bracket and lantern luminaires were designed in bronze by the Luminaire Studios of Curtis Lighting, Inc., to harmonize with the classical treatment of this beautiful interior.

WITH the development of light sources and methods of application have come changes in the procedure for planning and the manner of making calculations for artificial lighting. Hence, any book or treatise on engineered illumination, or the control of light, should include a discussion of the rules by which the ideas represented by the illustrations and the descriptive text may be put into practice in similar situations. Therefore, the following pages have been included to enable the architect and others interested in the specification of lighting materials to plan illumination for the usual types of buildings and find solutions for problems presented in our daily experience.

Complicated problems, those involving a rather expert knowledge, and those for which especially unique and unusual effects are desired, such as covelighting, architectural lighting, color effects, etc., should be planned in cooperation with a trained lighting specialist. It is for the purpose of rendering this special service that the Engineering Department of Curtis Lighting, Inc., has been organized and sales engineers are maintained in all principal cities.

The planning of lighting as discussed in this section of the book presupposes some knowledge of the fundamental principles of illumination and their correct application. Whoever is engaged in the planning of lighting must be conversant not only with the characteristics of the reflectors and lamps to be used, but also must give proper consideration to the influencing factors of the subject to be illuminated and of its surroundings, as for example, the reflection values of wall surfaces, the transmission factors of glasses and other diffusing media, the spectral character of color filters, etc., etc. On page 309 a number of definitions are given describing the terms ordinarily used in the discussion of lighting matters. These definitions may be helpful in clearing up many points in the mind of the user as to just what is meant by a particular unit or term. In addition, a number of interesting and valuable charts are included, some of which are of a rather general nature, others referring specifically to a particular kind of lighting application.

In the pages that follow it is impossible to touch upon all problems that might arise in the experience of the reader. The discussion has, therefore, been confined only to typical solutions. Some definite information and suggestions concerning the amount of illumination required for various types of buildings will be found and, in addition, illustrations and descriptions of many kinds of equipment that have been designed to do specific lighting work.

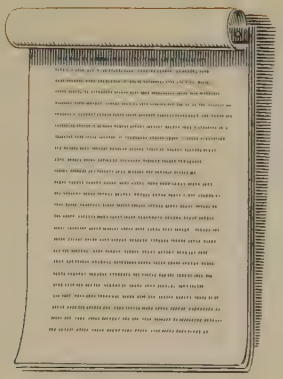
It may be noted that the arrangement of the material in this section of the book follows the same order as has been carried out in the previous section on Modern Lighting Practice, so that any subject may be found in the same relative position as it occurs in the previous section. References have been made in this section on planning to other portions of the book where specific illustrations are found that will enable the user to more definitely picture the results to be obtained by the equipment to be specified. The Index of the book should be generously used as it will be very helpful in finding pertinent information.

In the planning of any lighting system a number of fundamental points must be taken into consideration as, for example, the proper system of lighting, whether it be direct or indirect illumination, must be selected depending upon the nature of the interior or exterior, a choice of the amount of light, in intensity, that may be required must be determined, and finally a choice of equipment to produce the desired effects may be selected from suggestions that are given.

All lighting arrangements should be worked out in detail when the building or structure is being planned in the architect's office, otherwise, many compromises in illumination effect or architectural arrangement may be necessary. The ideal system of illumination becomes a part of its environment, fits in harmoniously, is not obtrusive, is something of which we are not wholly conscious, it produces the right effect or atmosphere, and properly interprets the architectural values. The ideal system is adequate in its physical properties of giving the correct amount of illumination desired or needed, and delivers the light just where it is most needed by utilizing equipment that has been designed and intended for accurate light control. Furthermore, it must be planned to take care of future increasing requirements imposed by the demands of the user or the advances in lighting practices.

Frequently in the study of certain types of lighting one might, at first thought, consider that the proper solution would call for specially designed reflectors and accessories. By a careful study, however, of the performance of the various units, it is evident that all standard reflectors may be used in a variety of ways. This flexibility of application is one of the fundamental ideas carried out in the design of all Curtis Lighting devices and systems of illumination.

It is important, of course, to keep in mind in the solving of any lighting problem, as was suggested in the early pages of the book, that the proper merging of the three principal factors of utility, hygienic effect, and artistic elements must be harmoniously accomplished. It is in this respect that the judgment and experience of the planner is called upon inasmuch as a final happy solution of the problem depends upon the satisfactory balancing of these important factors.



CALCULATIONS AND EQUIPMENT

EVERY problem in illumination involves the selection first of a type of lighting system or equipment. The kind of devices and accessories chosen must deliver the correct amount of light properly directed for best utilization in a harmonious and glareless manner, in addition to satisfying the artistic requirements imposed.

Direct lighting systems employ luminaires which send the greater portion of the light direct to the surfaces to be illuminated.

Formerly, open reflectors, both glass and metal, were the most common types of luminaires. With the advent of more powerful sources, the use of open-type reflectors has largely been discontinued. Open type metal and silver mirrored glass reflectors, however, are being used successfully in the industrial lighting field. Figure 579, page 277, shows the type of X-Ray reflector used in a direct lighting luminaire.

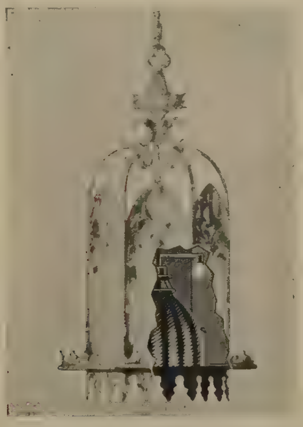


FIGURE 579—Typical direct lighting luminaire of the lantern type.

Semi-indirect lighting is obtained with units from which a portion of the light is reflected to the ceiling by the interior of the glass bowl. The remaining portion is transmitted through the bowl, causing the bowl to appear brightly illuminated.

Indirect lighting utilizes the ceiling and upper side wall for the redirection and diffusion of all the light emitted by the luminaires. With the entire ceiling as the light source an evenly distributed illumination is obtained, direct glare from the unit is avoided, and shadows are reduced to a minimum. The most efficient luminaires of this type employ a mirrored glass reflector within the bowl to direct the light to the ceiling. Figure 580 illustrates a totally indirect lighting unit employing a silver mirrored reflector. Indirect lighting may be obtained by other means than fixtures, namely: coves, wall urns, and art lamps.

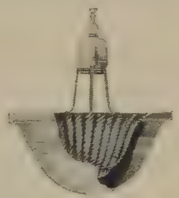


FIGURE 580—Indirect lighting luminaire of the opaque bowl type.

The X-Ray luminous bowl fixtures are truly indirect and are not to be confused with so-called semi-indirect. Just as in the opaque indirect fixture of metal or compone each lamp is equipped with an opaque reflector for the purpose of directing the light rays against the ceiling at the correct angle, thus insuring perfect indirect illumination. When several lamps and reflectors are used in the bowl, provision is made for a small lamp, the only function of which is to illuminate very softly the glass bowl or panels in the fixture. When but one lamp and reflector are used, a cup of translucent opal glass is set into a hole at the bottom of the reflector as in Figure 581, permitting a small percentage of the light to pass through and evenly illuminate the bowl.

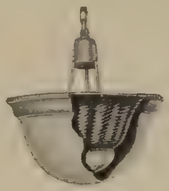


FIGURE 581—Indirect lighting luminaire of the luminous bowl type.

With this method, the bowl is not glary, harsh or obtrusive, no matter how bright the lamp may be. The small direct lighting component casts no objectionable shadows nor does it ruin the beautiful indirect illumination which is so essentially an illumination from concealed sources. In short, the luminous bowl X-Ray indirect lighting fixtures possess artistically lighted bowls and do not sacrifice the indirect effect originally sought.

Method of Planning

The most convenient method now in common use for the making of lighting calculations is known as the flux of light method, or lumen method. The application of this method is dependent upon a full knowledge of the characteristics of the lighting equipment and its applications to the different types of interior.

TABLE NO. 1

SPACING OF OUTLETS AND MOUNTING HEIGHT FOR DIRECT LIGHTING			
Ceiling or Mounting Height	Spacing Between Outlets	Area Per Outlet	Minimum Mounting Height
8 FEET	7 FEET	49 SQ. FT.	8 FEET
9 "	8 "	64 " "	8½ "
10 "	9 "	81 " "	9 "
11 "	10 "	100 " "	10 "
12	11 "	121 " "	10½ "
13 "	12 "	144 " "	11 "
14 "	14 "	196 " "	12½ "
15 "	16 "	256 " "	14 "
16 "	18 "	324 " "	15 "
18 "	20 "	400 " "	16 "
20 "	22 "	484 " "	18 "
22 "	24 "	576 " "	20 "
24 "	26 "	676 " "	21 "
26 "	28 "	784 " "	22 "
30+ "	30 "	900 " "	24 "
NOTE:- Distance between outside outlets and wall is usually one-half of the actual spacing between units.			

There are four steps in designing a general lighting system for any interior by the lumen method.

The foundation of the lighting system is the wiring plan and it should be given careful consideration. The cost of relighting consists largely of wiring costs, therefore, in planning a lighting installation provision should be made for future as well as present needs as more light is used year by year.

When the outlets are properly installed with correct spacing and size of wire, any change in the type of lighting unit or in the size of lamp may be easily made without rewiring. But where the outlets have been spaced too far apart or the wiring is inadequate, satisfactory results cannot be obtained without rewiring the whole system.

Spacing of Outlets

The structural features of the interior, in many cases, determines the location of outlets, particularly in new buildings where the wiring is installed before the type of lighting unit is decided upon.

TABLE NO. 2

SPACING OF OUTLETS AND SUSPENSION FOR INDIRECT LIGHTING			
Ceiling Height	Spacing Between Outlets	Area Per Outlet	Distance from Top of Bowl to Ceiling
9 FEET	9 FEET	81 SQ. FT.	24 INCHES
9½ "	10 "	100 " "	26 "
10 "	11 "	121 " "	28 "
10½ "	12 "	144 " "	30 "
11 "	12 "	144 " "	32 "
11½ "	13 "	169 " "	34 "
12 "	13 "	169 " "	36 "
13 "	13 "	169 " "	36 "
14 "	14 "	196 " "	36 "
15 "	15 "	225 " "	42 "
16 "	16 "	256 " "	42 "
18 "	17 "	289 " "	42 "
20 "	18 "	324 " "	48 "

The maximum allowable spacing between lighting units determines the number of outlets to provide for any given area. The relation between mounting height and spacing is based on the distribution of light required to give a reasonably uniform illumination on the working plane.

For practical purposes the spacing may be approximately the mounting height of lamps above the floor, since the working plane is only 2½ to 3½ feet above the floor. In most cases, a spacing in feet which does not exceed this mounting height will result in reasonably uniform illumination. See Tables No. 1 and No. 2.

However, the arrangement of bays, columns, and positions of work sometimes suggest a closer spacing in order to give a symmetrical layout, or a more favorable location with respect to work positions.

Mounting Height

When direct lighting units are spaced less than the maximum permissible distance, they may be dropped from the ceiling for reasons of appearance and ease of cleaning, but in no case should they be dropped below the minimum value shown in Table No. 1, Page 278. Suspensions for indirect luminaires are shown in Table No. 2, Page 278.

Adequate Wiring

The Underwriters' Code specifies wiring conditions

TABLE NO. 3

Present Standards of Foot-Candle Illumination for

COMMERCIAL INTERIORS

	Foot-Candles Recommended
Armories:	
Drill Sheds	10
Exhibition Halls	12
Art Galleries:	
General	5
On Paintings	25–100
Auditoriums	5
Automobile Show Rooms	15
Bank:	
Lobby	10
Cages and Offices	15
Barber Shop	15
Base Ball—Indoor Game	15
Basket Ball	15
Bowling:	
On Alley, Runway and Seats	8
On Pins	25
Billiards—General	6
On table	25
Churches:	
Auditorium	3
Sunday School Room	8
Pulpit or Rostrum	12
Art Glass Windows	25–50
Club Rooms:	
Lounge	5
Reading Room	12
Court Rooms	10
Dance Halls	6
Dental Offices:	
Waiting Room	6
Operating Office	12
Dental Chair	50
Depot—Waiting Room	8
Drafting Room	25
Garage—Automobiles:	
Storage—Dead	3
Live	8
Repair Dept. and Washing	15
Gymnasiums:	
Main Exercising Floor	12
Swimming Pool	8
Shower Rooms	6
Locker Rooms	6
Halls, Passageways in Interiors	3
Handball	25
Hospitals:	
Lobby and Reception Room	6
Corridors	3
Wards (with local illumination)	5
Private Rooms	8
Night Illumination	0.2
Operating Table	100–200
Operating Room	15
Laboratories	15
Hotels:	
Lobby	8
Dining Room	6
Kitchen	10
Bed Rooms	8
Corridors	3
Writing Room	12
Library:	
Reading Rooms	12
Stack Room	6
Lodge Rooms	6
Lunch Room	12
Moving Picture Theatre:	
During Intermission	5
Museum:	
General	8
Special Exhibits	25–100
Office Buildings:	
Close Work	15
No Close Work	10
File Room	6
Vault	6
Reception Room	6
Post Office:	
Lobby	10
Sorting, Mailing, etc.	15
Storage	10
Private and General Offices	15
File Room and Vault	6
Corridors and Stairways	3
Railway:	
Depot—Waiting Room	8
Ticket Offices	12
Rest Room, Smoking Room	8
Baggage Checking Office	12
Storage	6
Concourse	6
Train Platform	4
Restaurants	8
Racquet	25
Schools:	
Auditorium	8
Class Rooms, Library and Office	12
Corridors and Stairways	5
Drawing	25
Laboratories	12
Manual Training	12
Sewing Rooms	25
Study Room—Desks and Blackboards	12
Skating Rink (Indoor)	8
Squash	25
Stores—Department and Large Specialty:	
Main Floors	15
Other Floors	12
Basement Store	15
Stores—Medium Size:	
Art	12
Book	12
China	12
Clothing	15
Dry Goods	15
Electrical Supply	15
Hat	15
Jewelry	15
Music	12
Telephone Exchanges:	
Operating Rooms	8
Terminal Rooms	12
Cable Vaults	6
Tennis (Indoor)	25–50
Theatres:	
Auditorium	3
Foyer	8
Lobby	12
Toilet and Washrooms	6

in regard to the fire hazard, but does not take into consideration the economy of operation. The size of wire for a lighting installation may conform strictly to the Underwriters' Code and at the same time cause excessive voltage drop due to the length of the circuits. In a number of cases the unsatisfactory lighting, due to the low efficiency of the lamps and the waste of electrical energy because of overloaded circuits, is a direct result of inadequate wiring.

All classes of lighting installations should be wired so that the voltage drop between the panel box and outlets does not exceed 2 volts. This is computed for

TABLE No. 4

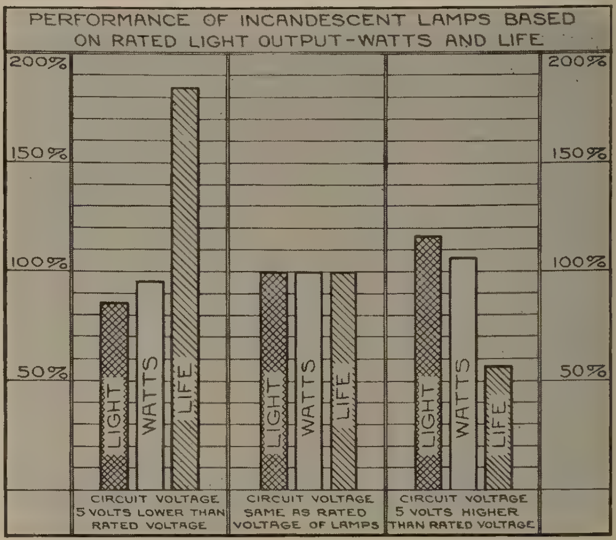
Present Standards of Foot-Candle Illumination for

INDUSTRIAL INTERIORS	Foot-Candles Recommended
Aisles, Stairways, Passageways	3
Assembling:	
Rough	8
Medium	12
Fine	20
Extra Fine	50–100
Automobile Manufacturing:	
Body Manufacturing—Assembly, Finishing and Inspecting	50–100
Bakeries	12
Candy Making	12
Cloth Products:	
Cutting, Inspecting, Sewing—	
Light Goods	15
Dark Goods	50–100
Pressing, Cloth Treating (Oil Cloth, etc.)—	
Light Goods	12
Dark Goods	20
Dairy Products	12
Electric Manufacturing:	
Storage Battery, Molding of Grids, Charging Room	10
Coil and Armature Winding, Mica Working, Insulating Processes	20
Foundries:	
Charging Floor, Tumbling, Cleaning, Pouring and Shaking Out	8
Rough Molding and Core Making	10
Fine Molding and Core Making	15
Garage—Automobiles:	
Storage—Dead	3
Live	8
Repair Dept. and Washing	15
Glove Manufacturing:	
Light Goods—	
Cutting, Pressing, Knitting	12
Sorting, Stitching, Trimming and Inspecting	15
Dark Goods—	
Cutting, Pressing, Knitting	15
Sorting, Stitching, Trimming and Inspecting	50–100
Ice Making:	
Engine and Compressor Room	10
Inspecting:	
Rough	10
Medium	15
Fine	25
Jewelry and Watch Manufacturing	50–100
Laundries and Dry Cleaning	12
Printing Industries:	
Matrixing and Casting, Miscellaneous Machines, Presses	12
Proof Reading, Lithographing, Electrotyping	15
Linotype, Monotype, Typesetting, Imposing Stone, Engraving	50–100
Textile Mills:	
(Cotton)—	
Opening and Lapping, Carding, Drawing-frame, Roving, Dyeing	8
Spooling, Spinning, Drawing-in, Warping, Weaving, Quilling, Inspecting, Knitting, Slashing (over beam end)	12
(Silk)—	
Winding, Throwing, Dyeing	12
Quilling, Warping, Weaving and Finishing—	
Light Goods	15
Dark Goods	20
Textile Mills:	
(Woolen)—	
Carding, Picking, Washing and Combing	6
Twisting and Dyeing	10
Weaving—	
Light Goods	12
Dark Goods	20
Knitting Machines	15

each length of run and should allow for a future increase in lamp size. This rule applies for 2 wire 110 volt circuits. For 3 wire 110/220 volt circuits the voltage drop should not be more than one volt.

Voltage Drop

Lamps give their rated light output, watts and life only when used at their rated voltage. This is usually found to be the most economical operation. Where current costs are high it may be advisable to operate lamps above their rated voltage. Where the power is obtained at a low rate, or where the lamps are rather inaccessible for maintenance, it may be economical to use lamps rated above the socket voltage. The performance of incandescent lamps based on their rated light output, watts and life is shown graphically in the illustration above.



In the second column the circuit voltage is the same as the rated voltage of the lamps. Therefore the lumen or light output, watts and life of the lamps are 100%.

In the first column the circuit voltage is 5 volts below the rated voltage of the lamps. The light output is 85.5% of the rated lumen output and the wattage consumed is 93%. The life of the lamps was increased to 186%.

The third column shows the results when lamps are operated 5 volts above their rated voltage. The light output is 117%, wattage consumption, 107%, and the life of the lamp 56%.

Foot-Candles Required

Research work in the studies of vision and observations of the results in actual installations have been the basis for our foot-candle recommendations. All the data taken in the laboratory point to the desirability of higher levels of illumination.

The foot-candle values given in tables No. 3 and 4 correspond to present standards for different classes of commercial and industrial interiors. These values represent good practice. In some cases, where higher foot-candle values than shown in this table are being used, it has been found that the benefits derived from the higher level of illumination more than offset the increased cost. The foot-candles required for any particular installation depend upon actual conditions, such as the accuracy of the work, the fineness of the detail being observed, the color of the goods being handled, and if the interior is a store, the advertising value due to the attractiveness of the well-lighted interior.

Room Efficiency

There is a certain percent of the total lamp lumens that reaches the working plane in any given installations. This percentage is called the Coefficient of Utilization. The first step in figuring the size lamp necessary for a desired foot-candle intensity is to determine this factor.

The variables which should be taken into account in determining the Coefficient of Utilization are interior finish, size and proportion of the room, the type of lighting equipment and the maintenance. Table No. 5, Page 281, gives the Coefficient of Utilization with due regard for the important variables.

Interior Finish

The effect of the reflection factor of the ceiling and walls upon the resultant illumination is very great. If the walls and ceiling of a room were finished black, the foot-candle illumination on any surface would be only that received direct from the lamps. If the same room were finished so that the walls and ceiling had a reflection factor of 50 per cent, the illumination would be practically doubled. Reflection factors of paint finishes are shown in Table No. 13, Page 312.

Room Proportions (Room Index)

Large rooms can be lighted more efficiently than small rooms of the same ceiling height because there is less wall area to asborb light in proportion to floor space.

The room index for any particular room will be found in Table No. 6 for indirect lighting, Page 282, and Table No. 7 for direct lighting, Page 283.

Procedure

To determine the Coefficient of Utilization for the installation, refer to Table No. 6—room index—for indirect lighting, and Table No. 7 for direct lighting. From this table find the room index which corresponds most nearly to the dimensions of the installation. Apply this in the use of Table No. 5, Coefficients of Utilization, which gives the proportion of the generated light from the lamps that reaches the plane of work. The Coefficient of Utilization for the installation of the type of lighting unit selected will be found in the proper column of wall and ceiling color opposite the correct room index.

FORMULAS FOR COMPUTING LAMP SIZE

(1) $A = \frac{B}{C}$

A—Area in square feet per outlet
B—Total floor area in square feet
C—Number of outlets

(2) $X = \frac{I}{UxD}$

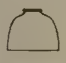
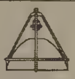
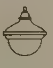
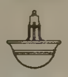
X—Lamp lumens required per square foot
I—Intensity desired in foot-candles
U—Coefficient of utilization
D—Probable average illumination in per cent of initial illumination

(3) $Y = AX$

Y—Lamp lumens required per outlet.

TABLE NO. 5

COEFFICIENT OF UTILIZATION···DIRECT & INDIRECT LIGHTING

Lighting Unit	Color of Ceiling	Very Light			Fairly Light			Fairly Dark	
	Color of Walls	Fairly Light	Fairly Dark	Very Dark	Fairly Light	Fairly Dark	Very Dark	Fairly Dark	Very Dark
	Room Index	Coefficients of Utilization							
 General Direct	0.6	.31	.26	.22	.31	.26	.22	.25	.22
	0.8	.38	.34	.30	.38	.33	.30	.33	.30
	1.0	.41	.39	.35	.40	.38	.35	.38	.35
	1.2	.45	.42	.38	.44	.41	.39	.40	.38
	1.5	.48	.45	.41	.47	.44	.41	.43	.40
	2.0	.52	.50	.46	.51	.49	.46	.48	.46
	2.5	.56	.53	.50	.55	.52	.50	.52	.50
	3.0	.58	.55	.52	.57	.54	.52	.54	.52
	4.0	.60	.58	.57	.59	58	.56	.57	.55
	5.0	.62	.60	.59	.60	.59	.58	.59	.57
 High Bay Direct	0.6	.42	.40	.39	.42	.40	.39	.41	.38
	0.8	.51	.49	.48	.49	.48	.47	.48	.46
	1.0	.55	.54	.53	.54	.53	.52	.52	.51
	1.2	.59	.58	.57	.57	.56	.55	.55	.54
	1.5	.61	.60	.58	.59	.58	.57	.58	.56
	2.0	.64	.63	.61	.62	.61	.60	.61	.59
	2.5	68	.65	.64	.65	.64	.63	.63	.62
	3.0	.69	.67	.65	.67	.65	.64	.64	.63
	4.0	.70	.69	.68	.68	.66	.65	.65	.64
	5.0	.72	.70	.69	.69	.67	.66	.66	.65
 Enclosed Indirect	0.6	.14	.11	.10	.11	.09	.07		
	0.8	.18	.14	.13	.14	.11	.10		
	1.0	.20	.17	.15	.15	.13	.11		
	1.2	.23	.20	.17	.18	.15	.13		
	1.5	.26	.22	.19	.20	.17	.15		
	2.0	.29	.26	.23	.22	.19	.17		
	2.5	.31	.28	.26	.24	.21	.20		
	3.0	.34	.31	.28	.25	.23	.21		
	4.0	.37	.34	.32	.27	26	.24		
	5.0	.39	.36	.34	.30	27	.26		
 Open Top Indirect	0.6	.15	.12	.10	.11	.09	.07		
	0.8	.18	.15	.13	.13	.11	.09		
	1.0	.22	.19	.16	.15	.13	.11		
	1.2	.25	.22	.19	.18	.15	.13		
	1.5	.27	.24	.21	.20	.17	.15		
	2.0	.30	.27	.25	.22	.19	.17		
	2.5	.34	.31	.28	.24	.22	.20		
	3.0	.38	.33	.30	.26	.24	.22		
	4.0	.40	.37	.34	.28	.26	.24		
	5.0	.42	.39	.37	.30	.28	.26		

Having determined the lamp lumens required per outlet by the above calculations, the wattage of Mazda lamps to be used may be found by reference to Table 9, which lists the lumen output rating for each size of Mazda clear lamps. Locate in this table the size of lamp of the desired type which most nearly meets the requirements of the lumen output. When the lamp lumens required fall nearly midway between two sizes, it will usually be found best to choose the larger size.

Table No. 6

ROOM INDEX FOR INDIRECT LIGHTING

CEILING HEIGHT		FEET								
		9-10	11-12	13-14	15-17	18-20	21-24	25-30	31-36	37-50
ROOM WIDTH (FEET)	ROOM LENGTH (FEET)	ROOM INDEX								
8-9	8-10	1.0	0.8	0.6	0.6					
	10-14	1.0	0.8	0.8	0.6					
	14-20	1.2	1.0	0.8	0.6					
	20-30	1.2	1.2	1.0	0.8					
	30-42	1.5	1.2	1.0	0.8					
	42+	2.0	1.5	1.2	1.0	0.8				
9-11	10-14	1.2	1.0	0.8	0.6	0.6				
	14-20	1.2	1.0	0.8	0.6	0.6				
	20-30	1.5	1.2	1.0	0.8	0.6				
	30-42	1.5	1.2	1.2	1.0	0.8				
	42-60	2.0	1.5	1.2	1.0	0.8				
	60+	2.0	1.5	1.5	1.0	1.0	0.8			
11-13	10-14	1.2	1.0	0.8	0.8	0.6	0.6			
	14-20	1.5	1.2	1.0	0.8	0.6	0.6			
	20-30	1.5	1.2	1.2	1.0	0.8	0.6			
	30-42	2.0	1.5	1.2	1.0	0.8	0.6			
	42-60	2.0	1.5	1.5	1.2	1.0	0.8			
	60+	2.0	2.0	1.5	1.2	1.0	0.8			
13-15	14-20	1.5	1.2	1.0	1.0	0.8	0.6	0.6		
	20-30	2.0	1.5	1.2	1.0	0.8	0.6	0.6		
	30-42	2.0	1.5	1.5	1.2	1.0	0.8	0.6		
	42-60	2.0	2.0	1.5	1.5	1.0	0.8	0.6		
	60-90	2.5	2.0	2.0	1.5	1.2	1.0	0.6		
	90+	2.5	2.0	2.0	1.5	1.5	1.2	0.8		
15-19	14-20	2.0	1.5	1.2	1.0	0.8	0.6	0.6		
	20-30	2.0	1.5	1.5	1.2	1.0	0.8	0.6		
	30-42	2.5	2.0	1.5	1.2	1.0	1.0	0.6	0.6	
	42-60	2.5	2.0	2.0	1.5	1.2	1.2	0.8	0.6	
	60-110	2.5	2.0	2.0	1.5	1.2	1.2	0.8	0.6	
	110+	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.8	
19-22	20-30	2.5	2.0	1.5	1.2	1.0	0.8	0.6	0.6	
	30-42	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6	0.6
	42-60	2.5	2.5	2.0	2.0	1.5	1.2	0.8	0.6	0.6
	60-90	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.6	0.6
	90+	3.0	2.5	2.5	2.0	1.5	1.5	1.0	1.0	0.8
22-26	20-30	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6	0.6
	30-42	3.0	2.5	2.0	1.5	1.2	1.2	0.8	0.6	0.6
	42-60	3.0	2.5	2.5	2.0	1.5	1.2	1.0	0.8	0.6
	60-90	3.0	2.5	2.5	2.0	1.5	1.5	1.0	1.0	0.6
	90+	3.0	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.8
26-33	30-42	3.0	2.5	2.5	2.0	1.5	1.2	1.0	0.8	0.6
	42-60	3.0	3.0	2.5	2.5	1.5	1.5	1.0	1.0	0.8
	60-90	4.0	3.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8
	90-140	4.0	3.0	3.0	2.5	2.0	2.0	1.5	1.2	1.0
	140+	4.0	3.0	3.0	2.5	2.0	2.0	1.5	1.2	1.0
33-40	30-42	4.0	3.0	2.5	2.0	1.5	1.5	1.0	0.8	0.8
	42-60	4.0	3.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8
	60-90	5.0	3.0	3.0	3.0	2.0	2.0	1.5	1.0	1.0
	90-140	5.0	4.0	3.0	3.0	2.5	2.0	1.5	1.2	1.0
	140+	5.0	4.0	3.0	3.0	2.5	2.0	1.5	1.5	1.2
40-45	42-60	5.0	4.0	3.0	3.0	2.0	1.5	1.2	1.0	0.8
	60-90	5.0	4.0	4.0	3.0	2.5	2.0	1.5	1.2	1.0
	90-140	5.0	4.0	4.0	3.0	2.5	2.5	2.0	1.5	1.2
	140-200	5.0	5.0	4.0	3.0	2.5	2.5	2.0	1.5	1.2
	200+	5.0	5.0	4.0	3.0	2.5	2.5	2.0	1.5	1.5
45-55	42-60				3.0	2.5	2.0	1.5	1.2	1.0
	60-90				3.0	3.0	2.5	1.5	1.5	1.2
	90-140				3.0	3.0	2.5	2.0	1.5	1.5
	140-200				3.0	3.0	2.5	2.0	2.0	1.5
	200+				3.0	3.0	2.5	2.0	2.0	1.5
55-68	60-90				4.0	3.0	2.5	2.0	1.5	1.2
	90-140				4.0	3.0	3.0	2.5	2.0	1.5
	140-200				4.0	3.0	3.0	2.5	2.0	1.5
	200+				4.0	3.0	3.0	2.5	2.0	2.0
68-90	60-90				5.0	4.0	3.0	2.5	2.0	1.5
	90-140				5.0	4.0	3.0	2.5	2.0	1.5
	140+				5.0	4.0	4.0	3.0	2.5	2.0
90+	60-90				5.0	4.0	3.0	2.5	2.0	1.5
	90-200				5.0	5.0	4.0	3.0	2.5	2.0
	200+				5.0	5.0	4.0	3.0	3.0	2.5

Table No. 7

ROOM INDEX FOR DIRECT LIGHTING

MOUNTING HEIGHT		FEET													
		7-8	8-9	9-10	10-12	12-14	14-17	17-20	20-24	24-30	30-36	36-50	50-64	64-80	80-100
RM. WIDTH (FEET)	RM. LENGTH (FEET)	ROOM INDEX													
8-9	8-10	1.0	0.8	0.6	0.6										
	10-14	1.0	0.8	0.8	0.6										
	14-20	1.2	1.0	0.8	0.6	0.6									
	20-30	1.2	1.2	1.0	0.8	0.6	0.6								
	30-42	1.5	1.2	1.0	0.8	0.6	0.6	0.6							
	42+	2.0	1.5	1.2	1.0	0.8	0.6	0.6							
9-11	10-14	1.2	1.0	0.8	0.6	0.6									
	14-20	1.2	1.0	0.8	0.6	0.6	0.6								
	20-30	1.5	1.2	1.0	0.8	0.6	0.6								
	30-42	1.5	1.2	1.2	1.0	0.8	0.6	0.6							
	42-60	2.0	1.5	1.2	1.0	0.8	0.6	0.6							
	60+	2.0	1.5	1.5	1.0	1.0	0.8	0.6							
11-13	10-14	1.2	1.0	0.8	0.8	0.6	0.6								
	14-20	1.5	1.2	1.0	0.8	0.6	0.6								
	20-30	1.5	1.2	1.2	1.0	0.8	0.6	0.6							
	30-42	2.0	1.5	1.2	1.0	0.8	0.6	0.6							
	42-60	2.0	1.5	1.5	1.2	1.0	0.8	0.6							
	60+	2.0	2.0	1.5	1.2	1.0	0.8	0.6							
13-15	14-20	1.5	1.2	1.0	1.0	0.8	0.6	0.6							
	20-30	2.0	1.5	1.2	1.0	0.8	0.6	0.6							
	30-42	2.0	1.5	1.5	1.2	1.0	0.8	0.6	0.6						
	42-60	2.0	2.0	1.5	1.5	1.0	0.8	0.6	0.6	0.6					
	60-90	2.5	2.0	2.0	1.5	1.2	1.0	0.6	0.6	0.6					
	90+	2.5	2.0	2.0	1.5	1.5	1.2	0.8	0.6	0.6					
15-19	14-20	2.0	1.5	1.2	1.0	0.8	0.6	0.6							
	20-30	2.0	1.5	1.5	1.2	1.0	0.8	0.6							
	30-42	2.5	2.0	1.5	1.2	1.0	1.0	0.6	0.6	0.6					
	42-110	2.5	2.0	2.0	1.5	1.2	1.2	0.8	0.6	0.6	0.6				
	110+	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6	0.6				
19-22	20-30	2.5	2.0	1.5	1.2	1.0	0.8	0.6	0.6						
	30-42	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6	0.6					
	42-60	2.5	2.5	2.0	2.0	1.5	1.2	0.8	0.6	0.6	0.6				
	60-90	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.6	0.6	0.6				
	90-140	3.0	2.5	2.5	2.0	1.5	1.5	1.0	0.8	0.8	0.6	0.6			
	140+	3.0	2.5	2.5	2.0	1.5	1.5	1.0	1.0	0.8	0.6	0.6			
22-26	20-30	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6	0.6					
	30-42	3.0	2.5	2.0	1.5	1.2	1.2	0.8	0.6	0.6					
	42-60	3.0	2.5	2.5	2.0	1.5	1.2	1.0	0.8	0.6	0.6				
	60-90	3.0	2.5	2.5	2.0	1.5	1.5	1.0	0.8	0.6	0.6	0.6			
	90-140	3.0	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6	0.6			
	140+	3.0	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.8	0.6			
26-33	30-42	3.0	2.5	2.5	2.0	1.5	1.2	1.0	0.8	0.6	0.6				
	42-60	3.0	3.0	2.5	2.5	1.5	1.5	1.0	1.0	0.8	0.6				
	60-90	4.0	3.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6	0.6			
	90-140	4.0	3.0	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6			
	140+	4.0	3.0	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6			
33-40	30-42	4.0	3.0	2.5	2.0	1.5	1.5	1.0	0.8	0.8	0.6				
	42-60	4.0	3.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6	0.6			
	60-90	5.0	3.0	3.0	3.0	2.0	2.0	1.5	1.0	1.0	0.6	0.6			
	90-140	5.0	4.0	3.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6			
	140+	5.0	4.0	3.0	3.0	2.5	2.0	1.5	1.5	1.2	1.0	0.8	0.6		
40-45	42-60	5.0	4.0	3.0	3.0	2.0	1.5	1.2	1.0	0.8	0.8	0.6			
	60-90	5.0	4.0	4.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6			
	90-140	5.0	4.0	4.0	3.0	2.5	2.5	2.0	1.5	1.2	1.0	0.6			
	140-200	5.0	5.0	4.0	3.0	2.5	2.5	2.0	1.5	1.2	1.0	0.8	0.6		
	200+	5.0	5.0	4.0	3.0	2.5	2.5	2.0	1.5	1.5	1.2	0.8	0.6		
45-55	42-60				3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6			
	60-90				3.0	3.0	2.5	1.5	1.5	1.2	1.0	0.6			
	90-140				3.0	3.0	2.5	2.0	1.5	1.5	1.2	0.8	0.6		
	140-200				3.0	3.0	2.5	2.0	2.0	1.5	1.2	0.8	0.6		
	200+				3.0	3.0	2.5	2.0	2.0	1.5	1.2	1.0	0.8	0.6	
55-68	60-90				4.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6		
	90-140				4.0	3.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6	
	140-200				4.0	3.0	3.0	2.5	2.0	1.5	1.5	1.0	0.8	0.6	
	200+				4.0	3.0	3.0	2.5	2.0	2.0	1.5	1.0	0.8	0.6	
68-90	60-90				5.0	4.0	3.0	2.5	2.0	1.5	1.2	0.8	0.6		
	90-140				5.0	4.0	3.0	2.5	2.0	1.5	1.5	1.0	0.8	0.6	
	140+				5.0	4.0	4.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6
90+	60-90				5.0	4.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6	
	90-200				5.0	5.0	4.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8	0.6
	200+				5.0	5.0	4.0	3.0	3.0	2.5	2.0	1.5	1.2	1.0	0.8

Designing an Indirect Lighting System

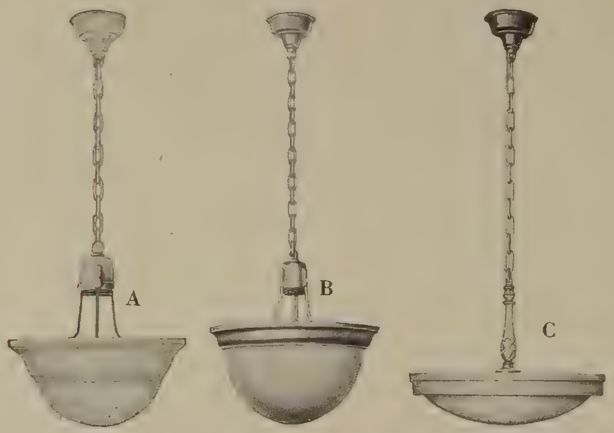


FIGURE 582—Commercial type luminaires. A—Metal bowl indirect; B—Luminous bowl indirect; C—Metal bowl indirect —Multiple light interior.

For a multiple unit interior the required number of lumens should be distributed among the several lamps. The highest efficiency is obtained by using a few large lamps instead of dividing the wattage up into many small lamps, due to the higher efficiency in lumens per watt of large lamps.

For purpose of convenience in designing the indirect lighting system, it is well to classify interiors according to the type of lighting units required.

Class No. 1 Commercial luminaires.

Class No. 2 Decorative luminaires of special design.

Class No. 3. Other forms of indirect lighting such as coves, wall urns, and portable lamps.

Indirect luminaires of the commercial type are either totally opaque or have the luminous bowl effect, both of which have previously been described. They are recommended for use wherever high intensity illumination uniformly distributed with minimum shadow, and absence of glare is desired at a low initial cost. Illustrations of indirect luminaires of the commercial type are shown by A-B-C of Figure 582.

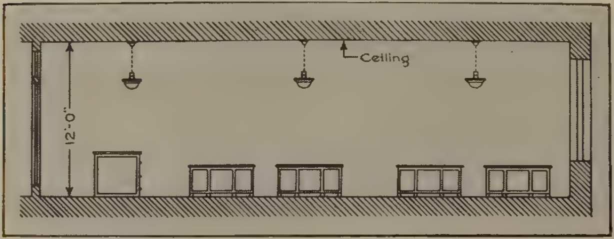


FIGURE 583—Section of an office showing the location of luminaires.

An office is an excellent example of such interiors and for that reason has been chosen to illustrate the method of procedure in designing indirect lighting.

In designing X-Ray indirect lighting it must be borne in mind that the ceiling of the room to be illuminated becomes the secondary source of light, hence the ceiling should be an efficient reflector in order that it will reflect and diffuse the maximum quantity of light. Ceilings finished in a matte white, very light creams or very light ivory are recommended. It has been found that a color for the ceiling similar to that of the ordinary United States Penny Post-card is most satisfactory. A glossy finish on the ceiling is as satisfactory as a matte finish from a standpoint of reflecting efficiency, but falls short in appearance and in ocular comfort. A blurred image of the lamp and reflector on the glossy surface produces a decided glare. It is best, therefore, to avoid the use of glossy finishes on ceilings when they are used as reflecting surfaces for indirect lighting.

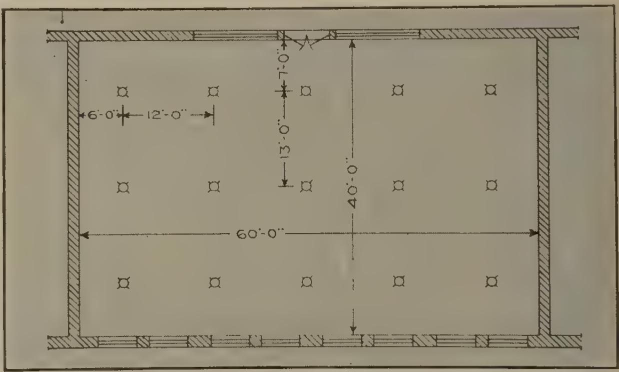


FIGURE 584—Plan view of an office showing the spacing of outlets.

Example

Given an office 40′ x 60′ with a 12′ ceiling. Walls are fairly light and ceiling is very light. The office is used for clerical work and bookkeeping which necessitates a high intensity illumination.

Solution

The location of outlets and mounting heights are the factors to consider first.

The number of outlets is dependent of course upon the dimensions of the interior and the character of the work carried on. In this case a uniform illumination is necessary and the room allows for a symmetrical layout of outlets.

From Table No. 2, page 278, the spacing is determined and the correct suspension may be obtained. The results are shown on the plan and sectional view of the office, Figures 583 and 584. The intensity of illumination required for this office is found to be 15 foot-candles from Table No. 3. Then from Table No. 6 the room index is 3.0, which when properly used in Table

No. 5 enables the designer to determine the coefficient of utilization for the room when lighted by an open indirect luminaire. In this case the coefficient of utilization is 0.36.

With the above information the proper size lamp required at each outlet is determined by substituting in the formulas listed on page 281. The solution is given below.

Substituting in formula (1)

$$A = \frac{40 \times 60}{15} = 160 \text{ sq. ft.}$$

Substituting in formula (2)

$$X = \frac{15}{.36 \times .70} = 59.5 \text{ lumens per sq. ft. required}$$

$$Y = 59.5 \times 160 = 9520 \text{ lumens.}$$

Referring to Table No. 9, Page 312, the lamp which would be selected for each outlet is the 500-watt or 9650 lumens. This is based on a depreciation of 30%.

Luminaires of Special Design

A luminaire of special design may be considered as "made-to-order" for the particular installation at hand. It may be readily compared to the "custom-built" motor car, as both differ from the stock product in much the same fashion. Both are planned to meet a particular need; a combination of the artistic and the practical.

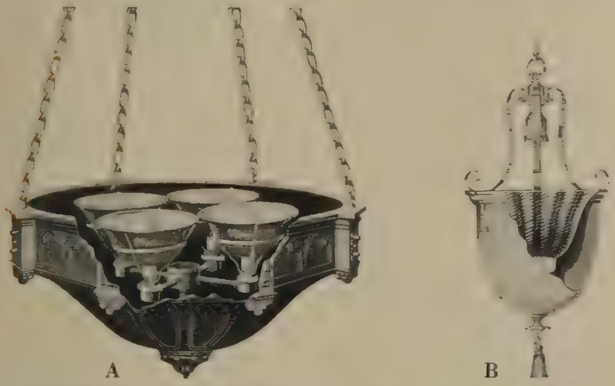


FIGURE 585—X-Ray luminaires of special design. A—Multiple light interior; B—single light interior.

A special luminaire may be designed to produce a special lighting effect, or to bring about a certain artistic result, but more often it is desired to create a combination of both.

An example of special design for artistic appearance only, would be an installation of a beautiful luminaire intended more as a piece of furniture and used to complete the space from an architectural standpoint even at times when no illumination was desired. In these days, however, an artistic design is seldom wanted without consideration for proper lighting effect.

Types "A" and "B" of Figure 585 illustrate typical indirect luminaires of special design. Type A being the totally opaque and Type B the luminous bowl type. Each of these has its particular application but more often individual taste is the deciding factor in selecting one or the other.

The opaque luminaire may be constructed of steel, brass, bronze, or compone. Inside the bowl one or more silvered mirrored X-Ray reflectors are arranged so as to direct the light to the ceiling.

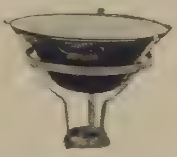


FIGURE 586—Cove lighting reflector of the semi-concentrating type.

X-Ray No. E-40 Reflector
Holder No. 8229
100-watt A-23 Mazda lamp

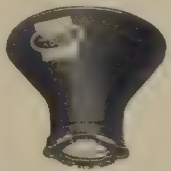


FIGURE 587—Typical cove lighting reflector of the concentrating type.

X-Ray No. EC-52 Reflector
Holder No. 11100
50-watt A-21 lamp
X-Ray No. EC-74 Reflector
Holder No. 11100
100-watt A-23 Mazda lamp

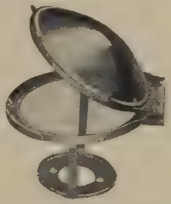


FIGURE 588—Color equipment showing glass color lens hinged to frame.

Color frame and lens for No. EC-52 and No. EC-74 X-Ray Reflectors

The hinge of the color frame has been designed so that the lens may be easily removed from the unit and replaced with a different color lens, if desired.

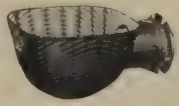


FIGURE 589—Typical cove lighting reflector of the distributing type.

X-Ray EC-50—50-Watt
X-Ray EC-100—100-Watt
X-Ray EC-150—150-Watt
X-Ray EC-200—200-Watt

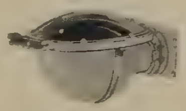


FIGURE 590—Color equipment showing glass color lens hinged to frame.

Color frame and lens for No. EC-50, 100, 150, 200 X-Ray Reflectors.

This hinged frame has the same removable characteristics as explained for the color frame in Fig. 588.

The luminous bowl fixture of special design may be of metal or compone with glass panels or the entire bowl may be of glass, supported by a metal band. The luminous bowl effect is obtained in the same way as described for the commercial units, namely; by small auxiliary lamps or by diffusing cups located in the bottom of the reflectors.

Other Forms of Indirect Lighting

The other forms of indirect lighting such as coves, wall urns and portable lamps may also be classed as "made to order" as they involve special application of standard equipment. The special X-Ray cove reflectors which have been developed have extended practical lighting methods so as to include the various conditions encountered, from the extremely high Gothic ceiling to the low flat ceiling. Illustrations of cove reflectors are shown in Figures 586, 587, 589, page 285.

The efficiency of cove installations compares favorably with installations using ceiling fixtures. In addition to the use of cove lighting in churches, and auditoriums, it is a practical method for theatres, ballrooms, lobbies and even residence lighting.

In order to evenly light the ceiling area the cove should be designed large enough to conceal the reflector equipment and located the correct distance from the ceiling. These factors are very essential if spotted and streaked effects are to be eliminated. A means should be provided whereby the reflectors can be easily reached for cleaning and renewal of lamps.

See illustration on page 106 for an excellent example of ceiling lighting without fixtures. Note how uniformly the ceiling is lighted—no splashes of light or blotches of shadows to indicate the position of the individual reflectors in the cove. This method gives the interior a spacious and dignified appearance.

Color Lighting Equipment

The usual way to produce color lighting in interiors such as theatres and ballrooms is by color equipment located in a cove. There are two methods used to equip the cove lighting units with colors, one is by means of colored lamps, either natural color or dipped, and the other by using glass color mediums over the front of the reflectors. Of the two methods the latter is the most preferred because of the uniform color effects which can be obtained. The renewal of lamps does not affect the color scheme as originally installed. The glass color mediums are permanent in color and when they are hinged to the reflector unit as shown by Figures 588 and 590 relamping is very easy. The glass color mediums may be obtained in red, blue, green, and amber.

When sprayed or natural color lamps are used for color effects it is very hard to secure a uniform quality. If the colors when first installed should match fairly close the renewal of lamps will soon vary the color quality of each color until an undesirable effect may be obtained. Because of these difficulties it is much better to use glass color mediums instead of colored lamps.

Wall Urns

Many times it is not practical to construct a continuous cove in which to conceal the reflector, but it is nevertheless desired to illuminate the interior by means of hidden reflectors. To meet this condition the EC-68 X-Ray reflector was developed. This unit can be used either in a continuous cove or can be located at various points about the room, on pilasters, or posts. Because of the special design and peculiar shape of this reflector, it can be placed directly against the wall and still will not allow the light to splash on the side wall above the unit. The reflector is so designed that the light will be projected to the ceiling away from the wall.

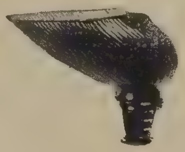


FIGURE 591—Special X-Ray reflector for wall urns using one 200-watt Mazda lamp.

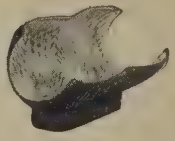


FIGURE 592—Special X-Ray reflector for wall urns using two 100-watt Mazda lamps.

Many of the difficulties of cove lighting and side wall brackette lighting have been overcome with this special unit. A large field for illuminating interiors by the concealed light method has been opened up since this type of unit was developed.

Sometimes the lighting units are placed in the top of partitions in a continuous row, in place of localizing them at specific points. The cornice then forms a continuous trough in which the reflectors are entirely concealed from view.

A wall urn lighting scheme is worked out in much the same way as in cove lighting. Care must be taken to space the boxes so as to obtain uniformly distributed illumination, also the distance from ceiling to top of reflector must be sufficient to assure the entire width of the ceiling being evenly lighted.

Other Methods of Lighting

Other methods of obtaining indirect illumination include floor pedestals, column clusters, and portable lamps equipped with Curtis Adapter. Fig. 376 shows a typical floor pedestal employing X-Ray reflectors to direct the light to the ceiling. Column clusters consist of one or more reflector units placed on each face of a column. Some decorative scheme is used to conceal the reflector and equipment. Figure 137 illustrates this method.

The Curtis Adapter is a novel device which may be readily attached to any floor or table lamp. Figure 594 shows a view of the 300-500 watt size. Figure 593 the 150-200 watt size.

Pulling one of the switches lights the small lamps around the edge of the disc, giving the shade the illuminated decorative effect of the usual art lamp. When a general illumination of the room is desired, pulling the other switch turns on the large lamp concealed in an X-Ray reflector. The light from this lamp and reflector is thrown to the ceiling and from there diffused throughout every corner and part of the room.

The powerful corrugated reflector is held in correct position with relation to the lamp to secure the most efficient results.

The bottom of the X-Ray reflector is open to receive a diffuser which allows light to pass through and illuminate the shade making the use of the small lamps unnecessary when the indirect light is turned on.

Floor and table lamps equipped with the Curtis Adapter have proven very successful for residences, reception rooms, small display rooms, and libraries.

The design of a lighting installation using the above mentioned schemes involves the same procedure as any of the indirect lighting systems previously described. The room dimensions and reflection factor of walls and ceiling are the essential points to consider. The location of such equipment cannot be determined by tables as the decorative features in the room govern this to a great extent. However, a uniform illumination is always desirable and some thought should be given to this detail.

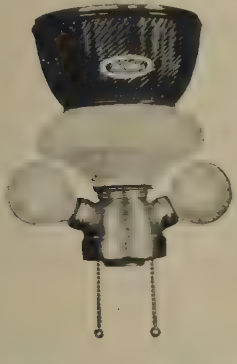


FIGURE 593—Curtis Adapter No. 3000—150-200 watt Mazda lamp.

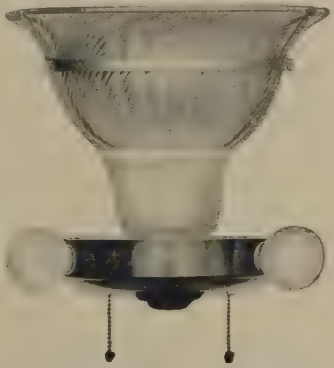


FIGURE 594—Curtis Adapter No. 2852—300-500 watt Mazda lamp.

Hospitals

There are a few types of interiors which warrant special attention due to their peculiar requirements of illumination. Among these are hospitals. The glare of exposed lamps is detrimental to the progress of the patient. The illumination should have the softness and diffuse quality of daylight. This can be obtained only by concealed lamps and with lighting by indirect methods.

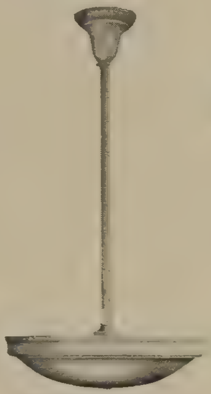


FIGURE 595—Luminaire for hospitals — multiple interior.

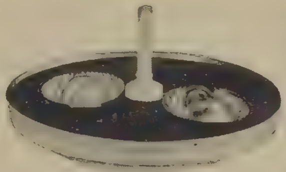


FIGURE 596—View of hospital luminaire showing reflector equipment.

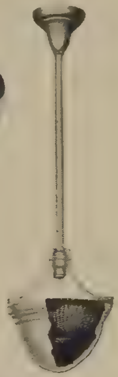


FIGURE 597—Luminaire for hospitals, single light interior.

Wards. For large ward lighting it has proven very satisfactory to control each fixture by an electrolier switch at the fixture or by a suitable switch on the wall arranged to give at least two intensities of illumination, and in some cases, three. A low intensity to enable the nurses to wait on patients at night is desirable; second, a medium intensity for reading, etc., and third, a high intensity for medical examination at the bed. The higher intensity is sometimes obtained by using wall plugs between the beds and localized reading lamps provided.

The private wards should be treated similarly to the bedroom of a residence, except that it is advisable to provide two intensities, low and medium, and baseboard receptacles for attaching portable direct lamps at the head of the bed.

In the wards and private rooms of some hospitals, ceiling fixtures have been entirely eliminated, the lighting being obtained from indirect lighting wall brackets above each bed.

The design of hospital ward lighting follows the same procedure as described previously where stock fixtures were involved. In this case, however, special fixtures of plain design are usually required. They are special in that the interior equipment is so arranged and wired that various intensities of illumination may be obtained. Also for many of the new hospitals, it is required that the indirect luminaire have a glass cover. This keeps dust out of the interior equipment and makes cleaning a simple task. Rod hangers are prescribed for most types of lighting fixtures used in hospitals, as they do not collect dust as do chain hangers. In this way the lighting equipment is made to conform to sanitary requirements as well as to good lighting practice. Figures 595 and 596 illustrate the multiple lamp fixture recommended for hospital wards and private rooms.

Corridors. The corridors of a hospital require only a low intensity of illumination with no exposed light sources. Indirect lighting is excellent for such locations and is used extensively in the corridors of many large hospitals. Figure 597 shows a small unit suitable for corridors and halls. Such units furnish illumination during the day, but at night it is advisable to avoid all overhead lighting. This prevents patients being annoyed by light coming through open doors and transoms.

Glo-Ray

To fill the need for this night lighting, a special unit was developed, "Glo-Ray," which is shown by A-B and C of Fig. 598. It produces soft subdued illumination upon corridor floors and stair landings, and is used to a great extent as a night-light in wards and private rooms.

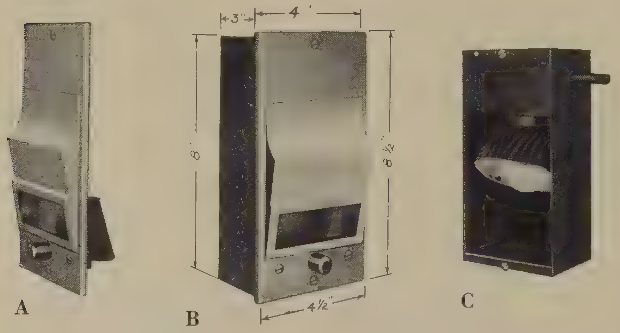


FIGURE 598—Glo-Ray night light. A—View of front cover; B—Complete unit; C—View of box showing reflector.

The Glo-Ray is installed generally from twelve to eighteen inches above the floor, and a small and efficient X-Ray Reflector directs the light at a downward angle through a glass window in the front cover of the unit. The quantity of light is controlled by a simple screw device just beneath the window, where it is accessible at all times.

This fixture consists of a metal box, a regulating device for control of the light, and an X-Ray reflector, holder and socket. The front covering of the box contains the glass window, through which the light passes down upon the floor or stair landing. The cover has a protective coating and may be painted or enameled to match the wall in which it is installed. The box is sturdily constructed of 14 gauge metal and is neatly finished in a protective coating of black enamel. The top of the box is provided with a wiring compartment with knockouts into which the feed wires are led from either side or top. The wiring is facilitated by means of a removable cover on the compartment.

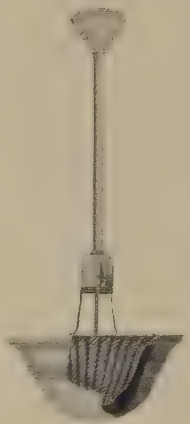


FIGURE 599—X-Ray luminaire for operating rooms, totally indirect.

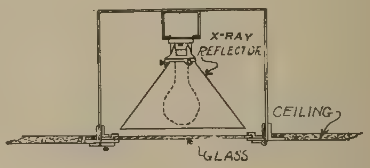


FIGURE 600—Operating room lighting by recessed direct lighting.

The Glo-Ray Night Light may be installed in a wall only three inches deep, as will be seen from dimensions in Fig. 598. The front cover fits flush against the wall, offering no obstruction.

Hospital Operating Rooms

In operating rooms where a very high intensity of light is required, the lighting equipment should be designed so that the surgeon may work without the possibility of standing in his own light; in other words, to preclude the possibility of shadows.

Indirect lighting in operating rooms is particularly effective when properly arranged, but if this manner of illumination is to be adopted, it must be carefully calculated to produce practically shadowless illumination of high intensity on the operating table. Where the operating room has a large enough ceiling area to utilize the indirect method of illumination, this method is often used in preference to direct lighting.

Figure 599 is an illustration of one of the popular types of Curtis units for operating room lighting. The

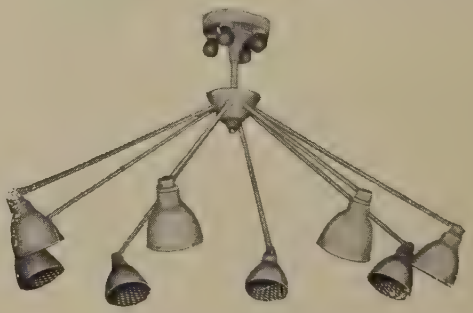


FIGURE 601—Special direct lighting unit for operating room lighting.

cutaway view demonstrates the principle of concealing the X-Ray Reflector within the bowl.

Where construction permits, and especially in new buildings, the reflectors are often recessed in box-like units such as shown in Fig. 600.

Figure 601 illustrates still another style of direct lighting unit for operating rooms. The overall diameter of this unit is approximately 70 inches. Each rod supports a metal housing which contains a silver mirrored X-Ray reflector for use with a 100 watt lamp.

Banks

Attractive and practical lighting results in banks may be secured in a variety of ways. They may be lighted by means of fixtures suspended from the ceiling, from special lighting boxes or urns on the walls, from units in the top of the banking screen or partitions, through skylights, or from brackets on columns and pilasters.

Recommended intensities for the various departments of a bank are found in the Table No. 3 on page 279. With this information and the lighting scheme determined it is only a matter of careful figuring to design the complete lighting plan.

Special care must be taken in distinguishing between lighting for general illumination such as required for the public spaces, and lighting for working areas.

General illumination is often obtained from indirect ornamental fixtures which fit into the scheme of architecture. These may be either pendants or brackets and are usually the luminous bowl type. Fig. 603 illustrates one type of indirect lighting bracket sometimes used in lighting the public space. The cut-away view shows the location of the X-Ray reflector.

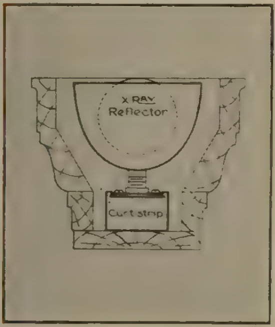


FIGURE 602—Indirect lighting from partitions.

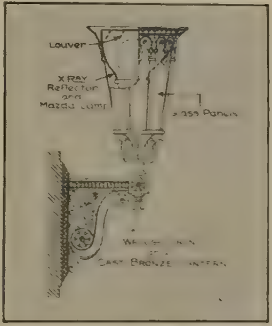


FIGURE 603 — Indirect lighting from ornamental brackets.

General illumination is frequently provided from reflector units concealed along the tops of the partitions. This method is unique in that hanging fixtures are eliminated entirely.

In case it is not practical to provide light for working areas with the same equipment as for general lighting, there are various methods of obtaining local lighting where it is needed.

Fig. 604 illustrates three methods of supporting the X-Ray Scoopette over bank counters in such a way as to properly light the working plane and at the same time avoid direct glare in the eyes of the teller.

The Brackette shown by "A" of Figure 604 consists of an X-Ray Scoopette mounted on a push key socket and equipped with a swivel base. The Scoopette housing and socket are brass and the rectangular base is cast bronze, 2″ long, 1″ wide, and $\frac{5}{16}$″ thick. A small wing nut is provided to tighten the swivel, thus the unit may be fixed in any position.

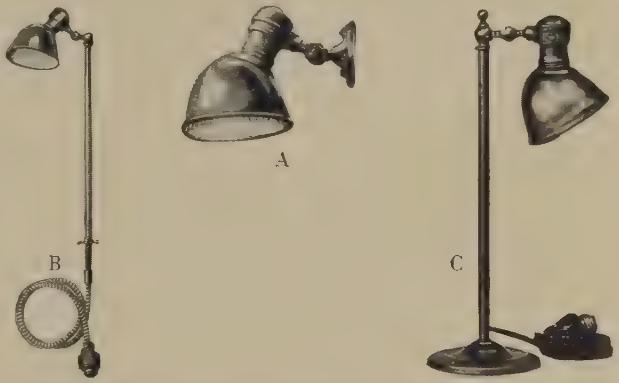


FIGURE 604—Auxiliary equipment for local lighting; A—X-Ray brackette; B—X-Ray brackette and standard; C—X-Ray deskette.

Illustration "B" of Fig. 604 shows the same Brackette with a ½″ brass pipe standard substituted for the cast base. This unit may be attached to a counter or table by means of the small circular plate holding it in place on top of the counter and the threaded pipe which extends through the counter and is fastened underneath with a plate and lock nut. The socket is of the push key type and the unit is adjustable. A flexible conduit is attached to this pipe and equipped with a fitting for connecting to a service box.

A similar unit which is portable is shown by illustration "C" of Fig. 604. The X-Ray Deskette is another way of supporting the Scoopette unit where high intensity local illumination is required for close work.

These units are for use with 25 or 50-watt A-19 lamps and are adaptable for tellers cages, coupon booths, and other locations in a bank where high intensity illumination is desired on a small area. They are especially adapted for the new low type bank screen. The scheme of illuminating the counter of this type of case construction is clearly illustrated in the photograph on page 89.

Direct Lighting Bank-Ray

Where the common type of bank cage is found, a high intensity of evenly diffused direct lighting at the wickets and around the inside of the cages may be obtained by the use of the equipment shown in Fig. 605. This type of lighting equipment is known as Bank-Ray.

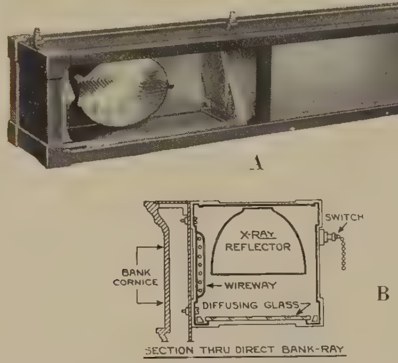

A
SWITCH
X-RAY REFLECTOR
BANK CORNICE
WIREWAY
DIFFUSING GLASS
B
SECTION THRU DIRECT BANK-RAY

FIGURE 605—Direct lighting Bank-Ray. A—View showing reflector and Bank-Ray housing. B—Detail showing method of mounting Bank-Ray to bank cornice.

Direct Lighting Bank-Ray consists of a special housing constructed of heavy gauge steel or bronze with front and back mouldings of ornamental design. The housing is $5\frac{7}{16}''$ high and $5\frac{11}{16}''$ wide, and is furnished in lengths as required. Contained in this housing are lamps and reflectors designed to direct the light downward through a diffusing glass upon the counter of the teller's cage. See A and B of Figure 605. The lamps, reflectors and all interior equipment are concealed from view by panels of $\frac{3}{16}''$ diffusing glass which form the bottom of the housing. The glass panels slide lengthwise to allow for cleaning and relamping of reflectors.

Indirect Lighting Bank-Ray

In some banks it may be desirable to use either totally indirect lighting or a combination of upward lighting for the public space, and downward lighting for the bank cage counter. This has been worked out in a practical way by using both types of equipment as shown by Figures 605 and 606. For the upward lighting, or indirect illumination, reflectors are provided for 150-watt lamps spaced at desired intervals throughout the length of the housing. (See Figure 606.) The switches and circuits are arranged so that the control of the direct lighting over the cage counter is independent of the indirect lighting equipment that produces the general illumination for the public space.

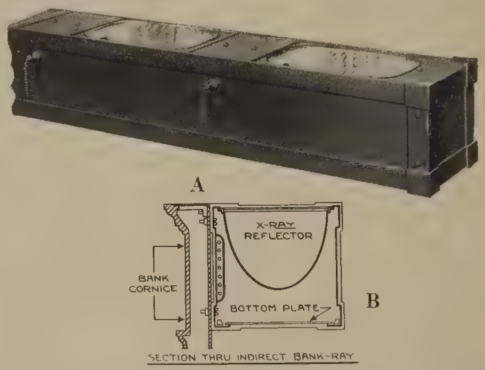

A
X-RAY REFLECTOR
BANK CORNICE
BOTTOM PLATE
B
SECTION THRU INDIRECT BANK-RAY

FIGURE 606—Indirect lighting Bank-Ray. A—View showing reflectors in Bank-Ray housing. B—Detail showing method of fastening housing to bank cornice.

Frequently, it is desirable to illuminate signs designating the number or function of the cage. To accomplish this reflectors and lamps may be placed in the metal housing, or a separate small lighting unit is installed independent of the general lighting equipment.

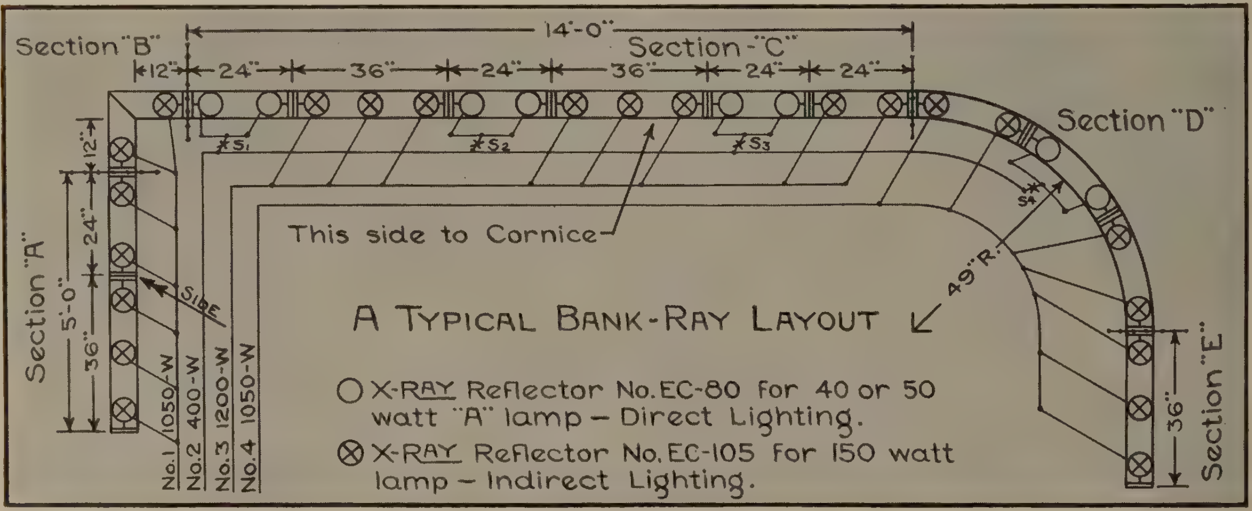

Section "B"
14'-0"
Section "C"
12"
24"
36"
24"
36"
24"
24"
S1
S2
S3
S4
Section "D"
12"
24"
5'-0"
36"
Section "A"
SIDE
This side to Cornice
49" R.
A TYPICAL BANK-RAY LAYOUT
No.1 1050-W
No.2 400-W
No.3 1200-W
No.4 1050-W
○ X-RAY Reflector No. EC-80 for 40 or 50 watt "A" lamp – Direct Lighting.
⊗ X-RAY Reflector No. EC-105 for 150 watt lamp – Indirect Lighting.
36"
Section "E"

FIGURE 607—Typical Bank-Ray layout showing direct and indirect lighting; also curved and right angle turns.

Direct Lighting

X-Ray reflectors for direct lighting are designed on the same principle of concealing the lamp as underlies the indirect lighting equipment. This principle of illumination from concealed sources is correct, whether the lighting be by direct means or indirect methods.

Industrial. Industrial lighting groups itself into two classes according to the type of equipment required. Ordinary industrial interiors require distributing type reflectors due to limited mounting height, while others having high bays necessitate concentrating units.

Both types of reflectors are applicable for use above diffusing glass and artificial skylights and will be discussed under that type of lighting.

The requirements which must be met in the choice of reflector equipment and in the design of a satisfactory lighting installation for industrial plants are:

1. A steady light of sufficient intensity on all working surfaces whether in horizontal, vertical, or oblique planes.
2. A comparable intensity of light on adjacent areas and on the walls.
3. Light of a color and spectral character suited to the purpose for which it is employed.
4. Freedom from glare and from glaring reflections.
5. Light so directed and diffused as to avoid objectionable shadows or contrasts of intensity.
6. A system which is simple, reliable, easy of maintenance, and reasonable in initial and operating cost.

The procedure in designing an industrial lighting system follows that of indirect lighting previously described.

Foot-candle intensities for industrial lighting are shown in Table No. 4 on page 280.

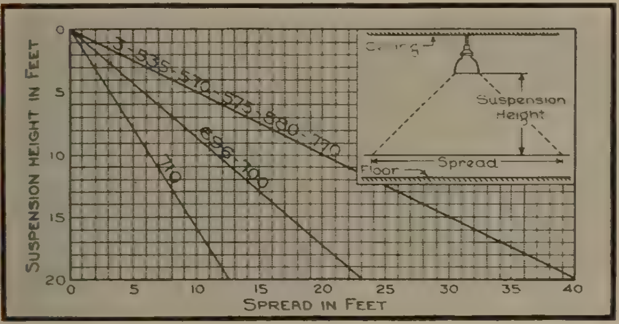


FIGURE 608—Spacing chart for X-Ray direct lighting reflectors.

Selection of Reflector and Hanging Height. These factors are dependent upon the dimensions of the space to be lighted and are described in detail in a previous section (Method of Planning). See Table No. 1, page 278. The chart shown in Fig. 608 refers to direct lighting reflectors and may be used to determine the maximum spread of a single reflector.

High Bay Direct Lighting

Reflector No. 590 on page 292, Figure 614, illustrates the unit which has a light distribution suitable for high bay interiors. The light from this unit is confined to a narrow zone, but owing to the extreme mounting height the spread is sufficient to cover the width of the bay. With this unit the over-all efficiency of the lighting installation is higher than if wide spread units are used. The spacing of this unit should never exceed $\frac{3}{4}$ of the mounting height above the working plane.

The room indexes for high bay interiors differ considerably from those of small rooms. In Table 7, page 283, are found the room indexes for high bay interiors.

Knowing the room index, the coefficient of utilization may be found in the section for high bay lighting. Table No. 5 on page 281. The procedure from here is like other calculations by the lumen method.

Example

Given a room 60′ x 200′ with a ceiling height below the roof trusses of 40 feet. The walls and ceiling are very dark. There is a large crane which travels the full length of the room. The room is used for a foundry for rough molding and core making.

Solution

The spacing and mounting height are the first factors to consider. The units must be mounted above the crane therefore a mounting height of 40 feet above the floor will be selected. The rule for maximum spacing of the high bay units being $\frac{3}{4}$ the mounting height above the working plane, it will be convenient to space the units on a 20′ by 30′ spacing. This gives three rows of units each 20 feet apart and 7 units per row spaced 30 feet apart. The intensity desired for this type of work is 12 foot-candles found in Table 4, page 280.

From Table No. 7, page 283, the room index is found to be 1.0, applying this factor to Table No. 5 (page 281) section for high bay direct, the coefficient of utilization is found to be 0.51.

Substituting in the formulas shown on Page 281

$$A = \frac{60 \text{x} 200}{21} = 571.5 \text{ sq. ft. per outlet.}$$

$$X = \frac{12}{0.51 \text{x} 0.70} = 33.6 \text{ lumens per sq. ft. required.}$$

$$Y = 33.6 \text{x} 571.5 = 19200 \text{ lumens required per outlet.}$$

Referring to Table No. 9, page 312, the size lamp which would be selected is the 1000 watt or 20200 lumen lamp. The above calculations are based on a depreciation of 30%.

Direct Lighting Reflectors

All direct lighting reflectors have been designed for a particular Mazda lamp. It is very important that the correct lamp and holder be used.

DIRECT LIGHTING EQUIPMENT				
Catalog Number	Holder	Mazda Lamp Wattage	Diameter	Height
3	H-2¼" O-2¼" O-2¼"	60·50·A·21 50·25·A·19 40·A·21	4½"	3¼"
535	H-2¼" O-2¼"	100·A·23 60·50·A·21	5¾"	5⅛"
570	A-3¼"	150·PS·25	7⅞"	6⅞"
575	A-3¼"	200·PS·30	9⅜"	8"
580	Spec.	300·PS·35 500·PS·40	11⅞"	9⅜"
54	Spec.	1000·750	16½"	13⅜"
590	Spec.	1500·1000	20"	10½"
696	H-2¼" O-2¼"	100·A·23 60·50·A·21	8"	5"
700	H-2¼"	150·PS·25	10"	5½"
710	A-3¼"	200·PS·30	11½"	6¾"

FIGURE 609—Complete table showing X-Ray direct lighting reflectors and giving the size lamp, proper holder and over-all dimensions.

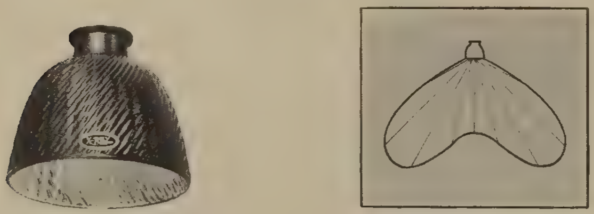


FIGURE 610—X-Ray Reflector and typical distribution curve for the No. 3, 535, 570 and 575 reflectors.

The above reflectors are used in direct lighting installation requiring a wide distribution of light.

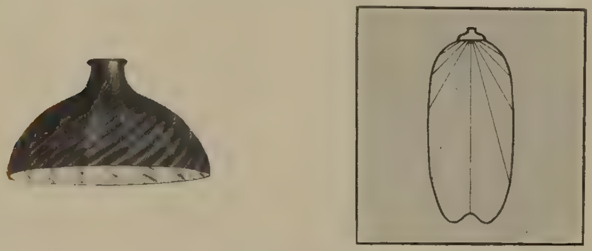


FIGURE 611—X-Ray reflector No. 710 and distribution curve for a 200-watt Mazda lamp.

The No. 710 reflector is semi-concentrating and may be used to light interiors through artificial skylights.

The No. 580 reflector is furnished with an adjustable holder, and is used with a 300 or 500-watt lamp.

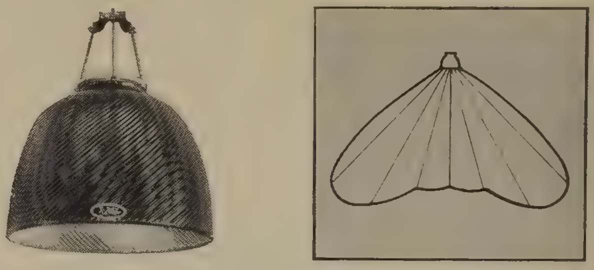


FIGURE 612—X-Ray reflector No. 580 and distribution curve for a 500-watt Mazda lamp.

The No. 54 reflector is applicable to large interiors where a high component of vertical light is desirable.

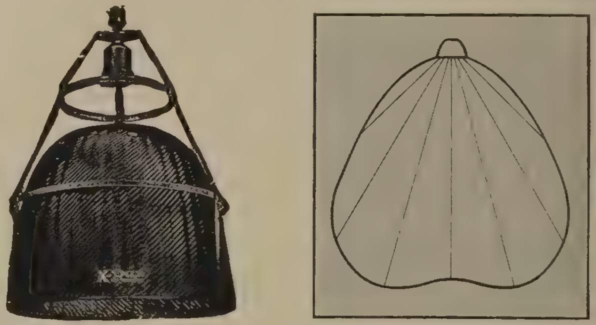


FIGURE 613—X-Ray reflector unit No. 54 and distribution curve for a 1000-watt Mazda lamp.

The No. 590 has been designed for high bay lighting where the units must be installed at high mounting.

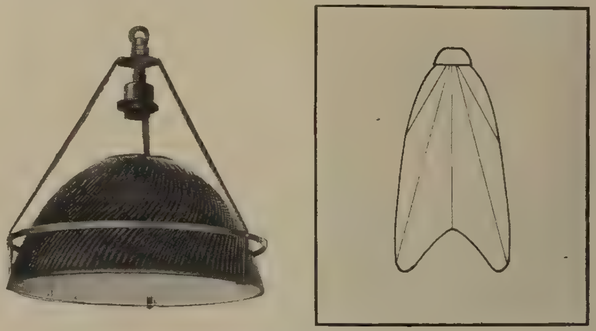


FIGURE 614—X-Ray reflector No. 590 and distribution curve for a 1000 or 1500-watt Mazda lamp.

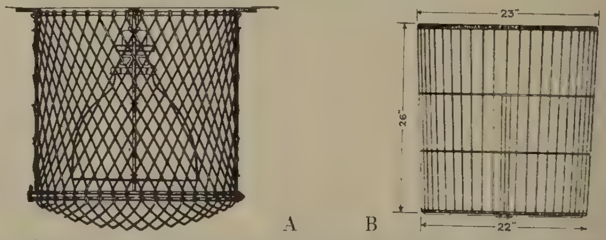


FIGURE 615—Wire guards for X-Ray reflectors. A—Typical wire guard for the No. 570, 575 and 580 reflectors. B—Wire guard for the No. 54 and 590 reflectors.

Special Applications of Direct Lighting

Armories, Field Houses, Gymnasiums. For large interiors such as Armories, Field Houses and Gymnasiums with high ceilings, the lighting equipment must be located at a comparatively great height so as to be out of the normal field of vision. The units must be so spaced as to provide an evenly distributed illumination over the entire floor. They must be accessible, easily cleaned, and of such design as to conceal the light source as much as possible.

Wherever practical, it is recommended that the reflector units be located between the steel beam trusses as they may be mounted at a greater height and also may be protected more easily. Wire guards should be provided for each unit. Typical units with wire guards in place are shown by A and B of Figure 615.

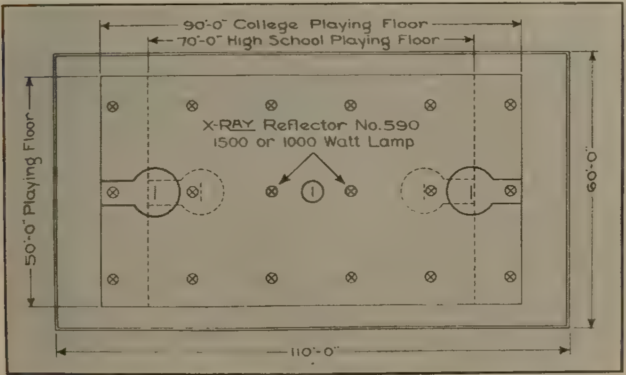

90'-0" College Playing Floor
70'-0" High School Playing Floor
X-RAY Reflector No. 590
1500 or 1000 Watt Lamp
60'-0"
50'-0" Playing Floor
110'-0"

FIGURE 616—Plan view of a gymnasium floor showing the outlet spacing.

In many cases it is desirable to space the lighting units at closer intervals over the actual playing floor to provide sufficient intensity for this area. A plan of a gymnasium floor is shown in Fig. 616.

The wattage required for each unit is determined by the lumen method, having determined from Table No. 3 on page 279, the intensity necessary.

Bowling Alleys and Billiard Tables

The illumination over the surface of a bowling alley should be uniform and a concentrated light of high intensity should be provided over the pins. Fig. 617 is a plan view of a bowling alley showing the way this may be accomplished with the use of X-Ray reflectors.

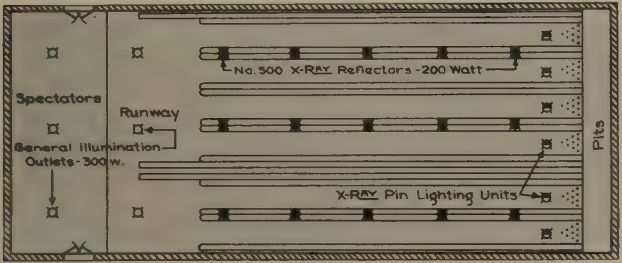

No. 500 X-RAY Reflectors - 200 Watt
Spectators
Runway
General Illumination Outlets - 300 w.
X-RAY Pin Lighting Units
Pits

FIGURE 617—Plan view of a bowling alley showing the spacing of outlets.

The plan view gives the correct location of outlets. At each outlet an angle type reflector should be installed so as to project the light down the alley away from the bowler. Due to the highly polished surface of the alley any light thrown back of the vertical will cause reflections which annoy the player. Wherever possible it is advisable to place the reflectors in front of beams and thus conceal the entire unit.

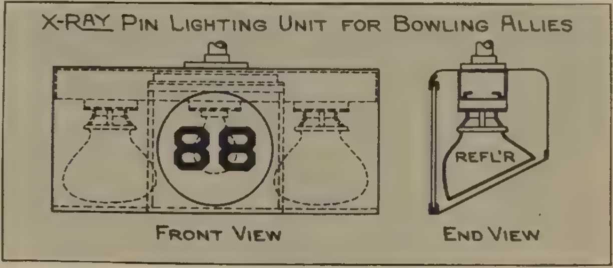

X-RAY Pin Lighting Unit for Bowling Allies
88
REFL'R
Front View
End View

FIGURE 618—Details of an X-Ray pin lighting unit for bowling alleys.

The single row of units for two alleys makes a very economical installation and at the same time practical from the lighting viewpoint.

Fig. 618 shows the special pin lighting unit which consists of two 50-watt X-Ray reflectors enclosed in a sheet metal housing. These reflectors project the light directly upon the pins causing them to stand out in contrast to the dark background.

For billiard table lighting the unit shown in Fig. 619 is recommended. This consists of a brass tube suspended horizontally from a chain hanger. Three X-Ray reflectors each for use with a 100 watt lamp are attached to this tube. The reflectors are protected by spun steel housings finished like the tube and hanger. A very evenly diffused illumination of high intensity results from the use of this unit above the table.

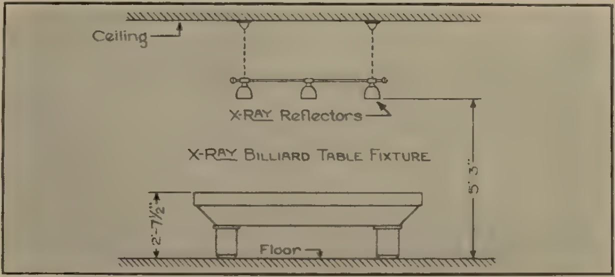

Ceiling
X-RAY Reflectors
X-RAY Billiard Table Fixture
2'-7½"
5'-3"
Floor

FIGURE 619—Billiard table lighting with X-Ray direct lighting unit.

Indoor Courts

Careful planning is necessary in designing the lighting for indoor courts such as squash, tennis, handball or raquet courts. These games are exceedingly fast and the utmost accuracy is required in playing the ball. Therefore the standard of illumination on the courts must be very high.

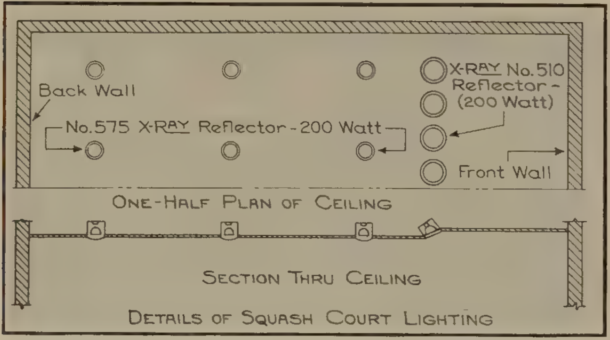

Back Wall
X-RAY No. 510 Reflector - (200 Watt)
No. 575 X-RAY Reflector - 200 Watt
Front Wall
ONE-HALF PLAN OF CEILING
SECTION THRU CEILING
DETAILS OF SQUASH COURT LIGHTING

FIGURE 620—A typical reflector layout for lighting an indoor court.

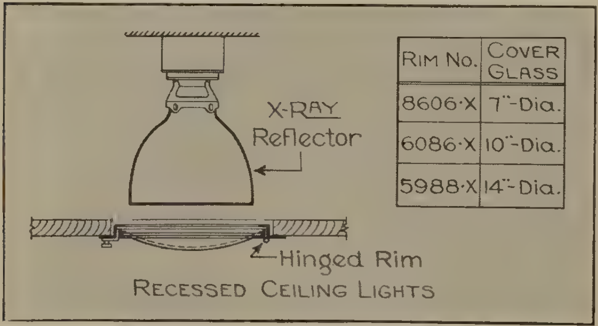
The one half plan view and cross section of ceiling, Figure 620, shows a typical layout for a standard squash court. As in the case of most of these games the front wall is the important area to be well lighted. All the lighting equipment shown in this plan has been recessed in the ceiling.

Artificial Skylight Lighting

The lighting of public spaces and lobbies from artificial skylights has been found very satisfactory in many large buildings.

X-Ray direct lighting reflectors of both distributing and concentrating types are used above skylights. The use of the concentrating or distributing types depends upon the available space above the skylight glass and the spacing of the units.

Figure 622 shows a bank lobby lighted by means of reflector equipment located above the skylight glass.



RIM No.	COVER GLASS
8606-X	7"-Dia.
6086-X	10"-Dia.
5988-X	14"-Dia.

FIGURE 621—Illustration of an X-Ray reflector recessed in a ceiling.

In Figure 623 will be seen the type of reflector used above the skylight glass of the above bank, and also the arrangement of the equipment. In this installation CurtiStrip was used to support the reflectors.

Direct Lighting in Churches

It has been previously stated that indirect lighting is the ideal system for churches. However, there are certain types of churches in which indirect lighting is not practical. This may be due to the architectural features of the interior or the characteristics of the ceiling and walls. See photographs on page 111.

The ceiling may be dark or heavy beams or paneling may prevent the use of indirect lighting. For such church interiors the lantern fixture is the most suitable.

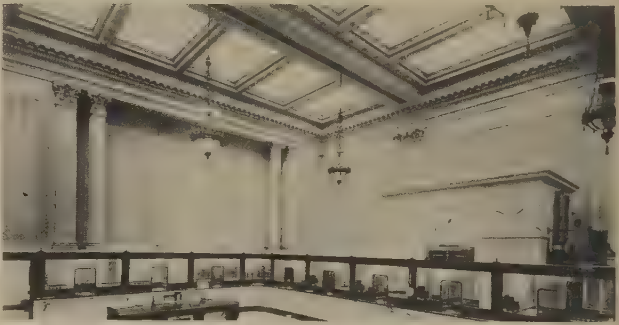


FIGURE 622—Bank lobby lighted with X-Ray reflectors above skylight.

When lanterns are used the principles of light control must be applied if the results are to be satisfactory. The application of control to light does not in any way affect the beauty of design. By careful use of the many X-Ray devices for direct light control, it is possible to minimize glare and provide adequate light where it is wanted.

The cutaway view in Figure 624 indicates how such an effect may be accomplished. Note the X-Ray reflector suspended above a disc of diffusing glass. One of the small lamps used to softly illuminate the side panels may also be seen. These side panels are usually of colored cathedral glass which softens the direct light of the lamps.

The deep beehive reflector conceals the large lamp and spreads the light over a wide area. The diffusing

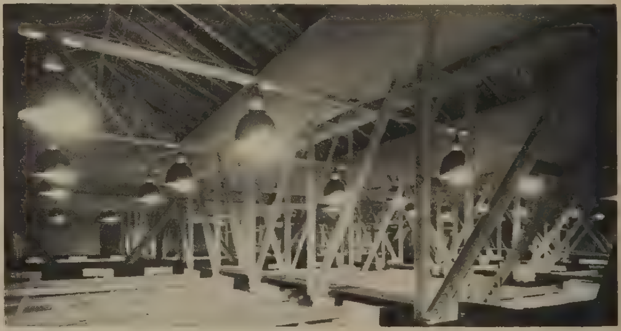


FIGURE 623—View above skylight in the bank of Figure 622 showing reflectors installed.

disc in the bottom is contained in a hinged frame which allows for cleaning and relamping the reflector.

Sometimes a beautiful effect may be produced by including small reflectors in the top of the lantern for indirect lighting along with the direct. See Figure 624. Such a scheme is often used to illuminate the decorations on the beams or ceiling.

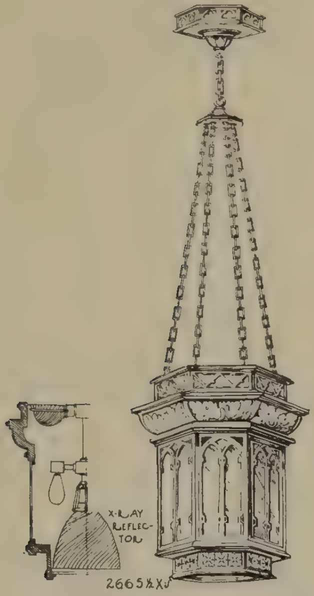


FIGURE 624—Direct lighting lantern with pilot chain suspension. Indirect lighting, for special effects, is also used in this luminaire.

The suspension of lanterns depends upon the ceiling height and also upon the area each fixture must light. Where a long suspension is required the pilot hanger is used. This is shown in Figure 624. The multiple chain hanger is connected to a single chain.

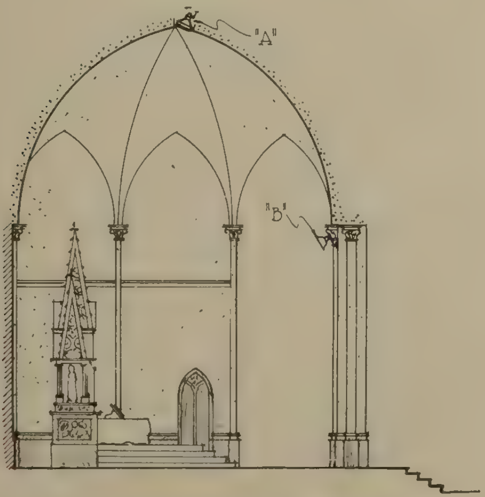


FIGURE 625—A typical method of lighting a church altar.

Lantern wall brackets are also used to provide illumination in churches. These are constructed similar to the pendant lantern just described, except that a non-symmetrical reflector is used to project the light toward the center of the room.

Lighting the Altar. The altar in the ritualistic church is the center of attention and should be lighted from concealed sources and to a high intensity.

One common method for lighting the altar is to conceal reflectors behind the sanctuary arch or recessing them in the ceiling as shown by "A" and "B" of Figure 625. Another method is to install a vertical row of small reflectors behind the sanctuary arch columns.

Pendants of low brightness, giving a decorative glow, or brackets with deeply shaded lights are frequently and very appropriately installed. The principal lighting, however, for the altar and for the choir should be from concealed sources. Decorative standards around the altar may be equipped with candle lamps frosted or tinted to reduce their brightness.

FIGURE 626—Special lighting effects for the stations of the cross.

Stations of the Cross. The stations may be lighted from concealed units in the base or in the canopy overhead. Fig. 626 shows a simple method of lighting the stations where wall construction allows.

FIGURE 627—Illumination of art glass windows with X-Ray reflectors.

Illuminated Windows. Some of the richest examples of modern art in the church are represented by the work of designing and installing beautiful windows.

Simple and effective lighting methods will reveal the beauty of the windows, whether they be seen from the street or by those inside the church attending services. Various methods have been employed for the lighting of the windows, depending upon the structural conditions to be encountered. One scheme is illustrated in Fig. 627 where a simple commercial type of floodlight is employed, with the units mounted at an inconspicuous location on the wall of the church lobby. Frequently, rows of reflector units, concentrating their light upon the window, are mounted upon beams so as to be hidden from view.

Show Window Lighting

The primary consideration in lighting a show window is to use the correct amount of light, so distributed as to illuminate the display in the most effective manner. To accomplish this, install the proper reflector and lamps, spaced to provide the right distribution and intensity, and located so that the light is thrown on the display in the most natural manner.

To light the window in the natural way, install the reflectors near the window glass, mounting them on or recessing them in the ceiling. The artificial lighting will then come from the same general direction as daylight and overhanging shadows will be reduced.

Where it is not possible to recess the reflectors, a valance should conceal the equipment, to "dress up" the appearance of the window.

Show Window Floodlighting

Curtis engineers were the originators of this method of show window lighting, which produces spectacular effects by means of emphasizing certain objects in contrast with their surroundings. The show window floodlight with "center spot beam" has become increasingly popular since its introduction into the lighting field, and it is now considered a standard article of equipment for all show windows.

Various sizes and types of show window floodlights are shown on page 301. They throw a flood of light over a fairly large area and direct a powerful center spot beam on the outstanding feature of a display. All floodlights are equipped with swivel bases to allow the unit to be directed as desired. Color frames are standard equipment although floodlights are obtainable without colors.

Where the center spot beam alone is desired, the flood or spill light can be eliminated by means of a "control-ring" (see page 301) which is easily clipped over the rim of the reflector.

"Superlighting" Show Windows

The merchant's most serious difficulty in making his window displays effective during the daytime is the presence of annoying reflections from the plate glass. There is no reasonable method for overcoming these reflections entirely, but *by increasing the amount of light in the window* they can be reduced to such an extent that they are not troublesome. In order to do this, high intensity illumination or "*super*-light" is necessary (see page 299). The reflectors are often installed on two circuits so that higher intensities can be had during the daytime than at night. In some localities, "*super*-lighting" of several hundred foot-candles intensity is employed so that the daylight reflections will be practically overcome.

Recessing Reflectors

The ceiling flanges shown on page 300 are used for recessing Reflectors in the ceilings of show windows. This method of installation conserves space and provides an extremely neat job.

The method of installing ceiling flanges is shown on page 300. Occasionally a portion of the ceiling of the window must be sloped to conform with the angle of the mouth of the reflector.

The holes in the ceiling should be cut ¼" larger than the mouth of the reflector and all rough edges will be covered by the flange. To secure the measurement of the mouth of any reflector, place it on a blank sheet of paper and draw a line around its edge.

X-Ray ceiling flanges have dimples moulded into them to receive X-Ray Color-Ray (see page 300).

Show Window Color Lighting

Certain types of displays are very effectively shown under colored light. When it is used with discretion, color lighting will produce results with greater attractive power than white light can possibly have. Each installation of window reflectors should be equipped for color lighting and all window floodlights should have a complete set of color equipment. This consists of a color frame for each reflector or floodlight, and four sheets of gelatins—in red, amber, green, and blue. These colors can be blended very effectively.

How to Select X-Ray Window Reflectors

The number of reflectors to use is optional with the merchant. No set rule can be established. It is influenced by a number of conditions, such as the brightness of neighboring windows, the intensity of the street illumination, kind of goods on display, color and nature of background in window, and largely the extent of the merchant's realization of the advertising and selling value of bright windows.

Spacing

The closer the reflectors are spaced, the brighter becomes the light in the window, and vice versa.

In average installations, the spacing, or distance from center to center of the reflectors, is from 12 to 24 inches.

For *super*-lighting, that is *high intensity lighting*, the X-Ray Giant No. 900 or X-Ray Leviathan No. 910 reflectors, with 500 or 300 watt Mazda lamps, should be used.

Under *ordinary conditions*, large windows should be lighted with X-Ray King No. 500 or X-Ray Queen No. 510 reflectors, with 200 watt Mazda lamps.

For *medium sized windows*, the X-Ray Jack No. 400 and the X-Ray Jill No. 410 reflectors, using 150 watt Mazda lamps, should be installed.

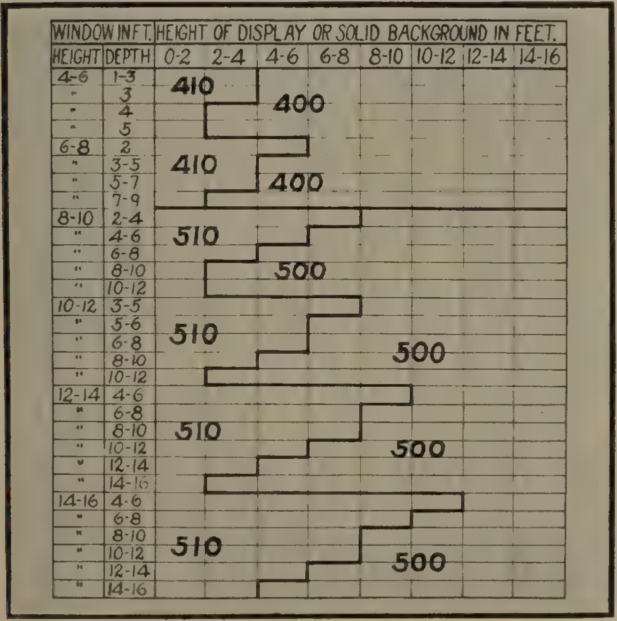
Small windows can be efficiently lighted by using the X-Ray Hood No. 731 or the X-Ray Scoop No. 778 reflectors with 100 watt Mazda lamps.

The accompanying table makes easy the selection of the correct reflector for any type of window. To start with, knowledge of three things is necessary— *Height reflectors are to be placed; depth of window from glass to background; and height to top of trim or background.*

In general the following spacing is suggested:

Large cities, business district—12″
Large cities, suburban district—12″–18″
Small cities —12″–18″
Towns —15″–24″

Chart Showing Reflectors to Install According to Window Dimensions


WINDOW IN FT.
HEIGHT
DEPTH
HEIGHT OF DISPLAY OR SOLID BACKGROUND IN FEET.
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
4-6
1-3
3
4
5
6-8
2
3-5
5-7
7-9
8-10
2-4
4-6
6-8
8-10
10-12
10-12
3-5
5-6
6-8
8-10
10-12
12-14
4-6
6-8
8-10
10-12
12-14
14-16
14-16
4-6
6-8
8-10
10-12
12-14
14-16
410
400
410
400
510
500
510
500
510
500
510
500

For "*super*-lighting" in large windows, Nos. 900 and 910 should be used in place of Nos. 500 and 510.

PLANNING WINDOW LIGHTING

1. Measure height reflectors are to be placed; depth of window from glass to background, and height from top to bottom of trim or background.
2. Refer to table above. Locate window height in left hand column. At this height, locate window depth at next column to right. Move along to the right to column corresponding to height of display or background as indicated across top of table. The reflector designated in this space is the reflector which should be used.
3. Determine spacing of reflectors according to locality of store, brightness of adjacent windows, and street and any other factors entering into the required intensity for that particular window.

The table shows the various sizes of window lighting reflectors. It will be found that the four reflectors, Nos. 400, 410, 500 and 510, will fill most requirements.

In making the installation the distance from the center line of the reflector to the plate glass window as given in column three of the following table should be adhered to. This allows sufficient space for cleaning the windows.

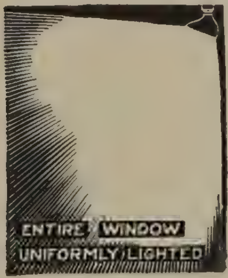
The second column of this table shows the width of each show window reflector, and should be used in determining the minimum spacing of the reflectors.

Types and Sizes of Reflectors

X-Ray Reflector	Width in inches	Center Line to Plate Glass in inches	Lamp Watts	Holder	Type	Cat. No. of Color Equip.
7 "Scoop Jr."	5	2¾	25–60	2¼″ O or H	Dist.	
11 "Hood Jr."	5	2¾	25–60	2¼″ O or H	Con.	
400 "Jack"	8½	5¼	150	Form X Included	Dist.	440
410 "Jill"	9⅜	5¾	150	Form X Included	Con.	441
500 "King"	10	6¼	200	Form X Included	Dist.	55
510 "Queen"	10½	6¼	200	Form X Included	Con.	55
731 "Hood"	8⅞	6	100*	2¼″ H	Con.	
778 "Scoop"	7½	5½	100*	2¼″ O	Dist.	
900 "Giant"	13	9	300–500	Special Included	Dist.	99
900 "Leviathan"	13	9	300–500	Special Included	Con.	99

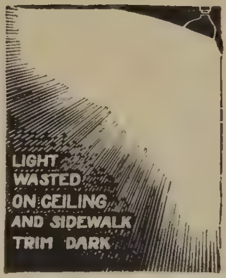
*For 100 Watt A-23 Mazda lamp only.
Dist.—Distributing type—gives wide spread of light.
Con.—Concentrating type—gives concentration of light.

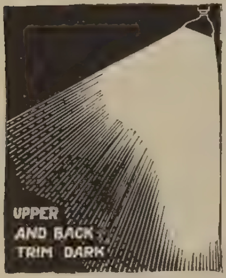
Why Certain Lamps and Holders Are Recommended for X-Ray Window Reflectors



The illustration at the left shows a reflector with the lamp in the correct position. The proper holder and correct lamp have been used in this reflector.

In the illustration at the right the lamp is too far down in the reflector. It shows that the wrong holder has been used or too large a lamp has been placed in the reflector.





The cut at the left illustrates the results obtained when the lamp is too far up in the reflector, which may be caused by using the wrong holder or too small a lamp.

Window Lighting Calculation

To obtain the average foot-candle value on the floor or backwall of a window, divide Factor "A" in the table of lamp wattage and spacing by Factor "B" in the table of window depth and height. Height is the distance from the floor to the socket.

"A" FACTORS		SIZE OF LAMPS IN WATTS				
		100	150	200	300	500
REFLECTOR SPACING	12"	1350	2200	3200	——	——
	15"	1080	1760	2560	4000	7520
	18"	900	1470	2130	3330	6270
	24"	675	1100	1600	2500	4700
	30"	540	880	1280	——	——
	36"	450	730	——	——	——

"B"-FACTORS			FOR No. 410-510-910 CONCENTRATING REFLECTORS							
DEPTH IN FEET			2	3	4	5	6	8	10	12
HEIGHT OF WINDOW	4'	WALL	18	26	35	60	125	165	250	400
		FLOOR	5	6	7	8	9	12	15	18
	6'	WALL	18	27	38	41	55	80	165	250
		FLOOR	6	7	8	10	11	14	16	20
	8'	WALL	18	27	38	40	50	70	125	200
		FLOOR	11	9	9	11	12	15	18	20
	10'	WALL	20	29	38	45	50	70	100	140
		FLOOR	13	10	10	11	13	15	18	20
	12'	WALL	24	30	38	45	55	75	85	110
		FLOOR	13	12	12	13	13	16	19	21
	14'	WALL	28	31	38	45	55	75	80	105
		FLOOR	13	13	14	14	15	17	20	22

"B"-FACTORS			FOR No. 400-500-900 DISTRIBUTING REFLECTORS							
DEPTH IN FEET			2	3	4	5	6	8	10	12
HEIGHT OF WINDOW	4'	WALL	10	13	17	21	25	33	45	55
		FLOOR	6	7	8	9	10	12	15	17
	6'	WALL	11	15	19	22	26	35	38	55
		FLOOR	8	8	9	10	11	13	16	18
	8'	WALL	13	16	18	19	26	33	41	50
		FLOOR	11	11	12	12	13	15	18	20
	10'	WALL	16	18	21	23	27	35	41	50
		FLOOR	14	14	14	15	15	17	20	21
	12'	WALL	18	20	22	25	29	33	41	50
		FLOOR	19	18	17	17	17	18	20	22
	14'	WALL	21	23	25	28	31	41	43	50
		FLOOR	20	20	20	20	20	20	23	25

Foot-Candle Values

The tables shown above provide a means of determining the average illumination that will be obtained on the floor or back wall of a window with various sizes of lamps and types of reflectors. For example:
Window Height 8 Feet; Depth, 6 Feet.
No. 400 Reflectors, 150 watts, 18-inch Centers.
"A" Factor, 1470.
"B" Factors: Wall, 26, Floor, 13.

Average Foot-Candles

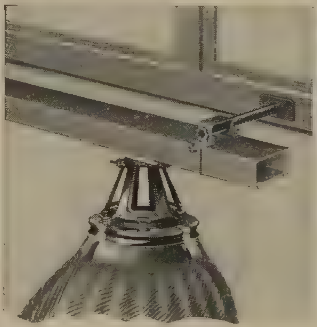
$$\text{Wall } \frac{1470}{26} = 56; \text{ Floor } \frac{1470}{13} = 113$$

The values are for the floor and back wall and *not* for the "line of trim," which is a more or less arbitrary location. The average value on the "line of trim" will, of course, be greater than the average for the wall and floor. This point should be kept in mind when using these tables.

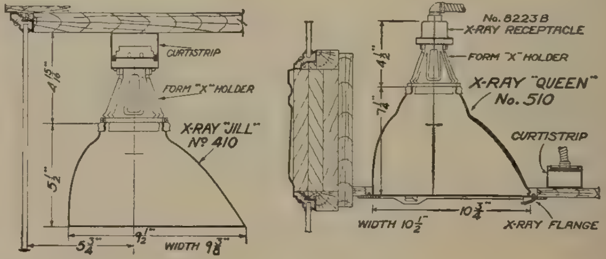
Since there are so many varying conditions, such as window depth, height, length, wattage and spacing of lamps, and type and size of reflectors, it has been necessary to make up the tables for certain limited conditions.

The tables are best suited for windows whose length along the front or sidewalk line is at least twice the mounting height of the reflectors, and the values are for the central portion rather than the ends of the windows.

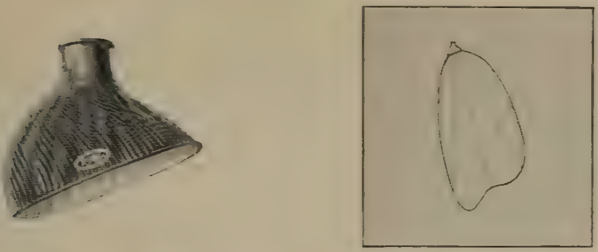
Installing Reflectors



Typical Methods of Installation

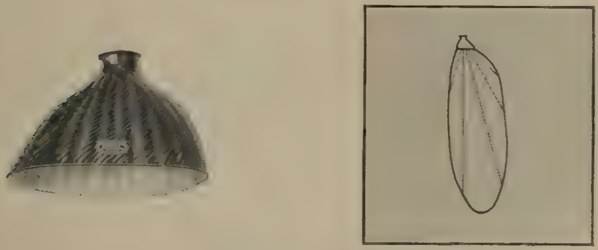


X-Ray Window Reflectors



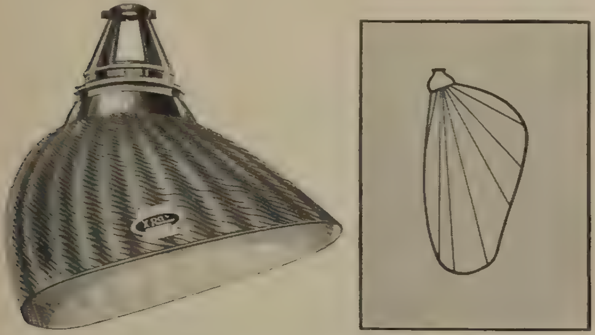
No 778 "Scoop" reflector—100-watt A-23 Mazda lamp.
Holder Form "O"—2¼".

This distributing type reflector is for small window.



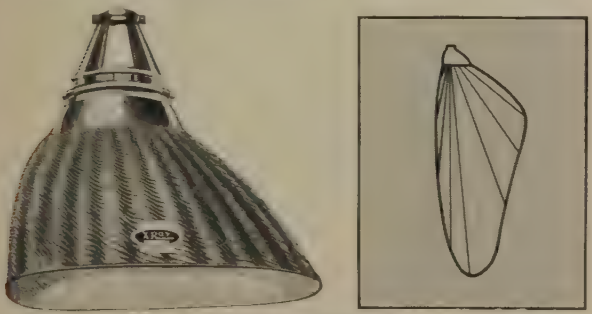
No. 731 "Hood" reflector—100-watt A-23 Mazda Lamp.
Holder Form "H"—2¼".

Concentrating type reflector used in small windows.



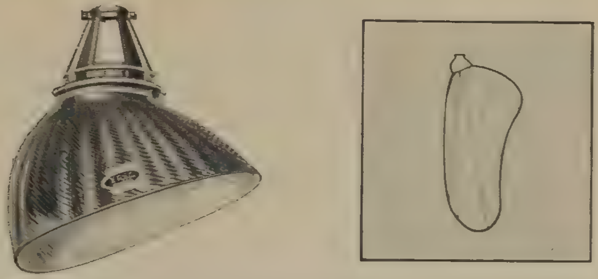
No. 500 "King" reflector—200-watt PS-30 Mazda lamp.
Form "X" Holder

Distributing type reflector as used in large windows.



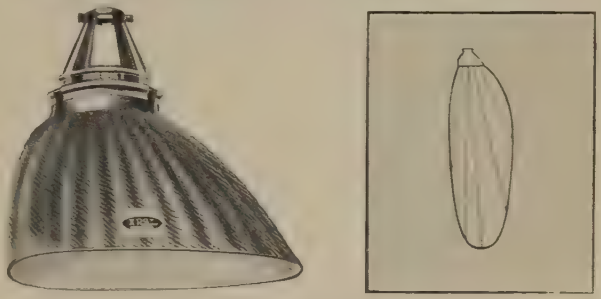
No. 510 "Queen" reflector—200-watt PS-30 Mazda lamp.
Form "X" Holder

The concentrating type reflector for large windows.



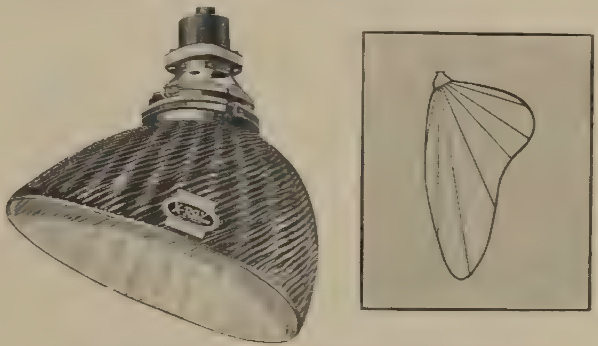
No. 400 "Jack" reflector—150-watt PS-25 Mazda lamp.
Form "X" Holder

Distributing reflector for medium sized windows.



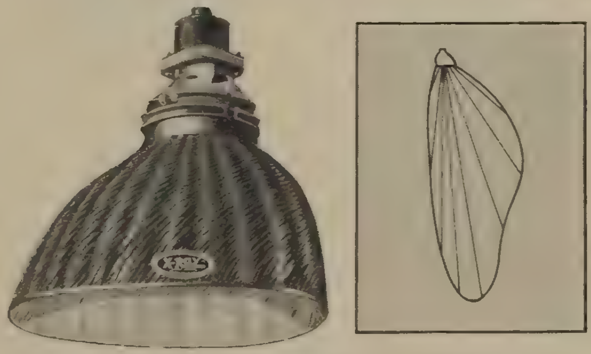
No. 410 "Jill" reflector—50-watt PS-25 Mazda lamp.
Form "X" Holder

Concentrating reflector for medium sized windows.



No. 900 "Giant" reflector—500-watt PS-40 Mazda lamp.
Special Holder.

Distributing type reflector used for super-lighting.

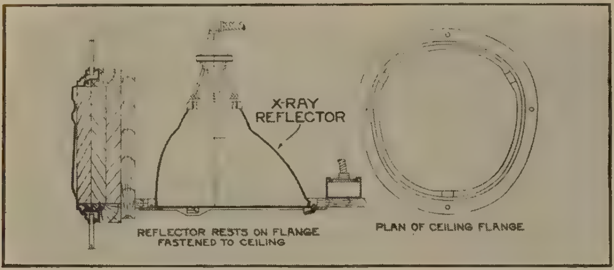


No. 910 "Leviathan" reflector—500-watt PS-40 Mazda lamp.
Special Holder.

The concentrating reflector used for super-lighting.

Ceiling Flanges

Ceiling flanges have been designed for the purpose of recessing show window reflectors in false ceiling.



Recessing Equipment—X-Ray ceiling flanges are metal rims for recessing Curtis X-Ray Reflectors in the ceiling of a show window. The illustration above shows the way X-Ray reflectors are installed on ceiling flanges. All flanges have three dimples moulded into the rim so the X-Ray color equipment may be easily attached to the flange. This feature permits the use of colors the same as in the ordinary window installations.

X-RAY RECESSING EQUIPMENT

No.	For X-Ray Reflector
11400	"Jack" No. 400
11410	"Jill" No. 410
11500	"King" No. 500
11510	"Queen" No. 510
10432	"Giant" No. 900 and "Leviathan" No. 910

Color-Ray

Color Equipment—Every well lighted window requires this flexible color equipment, consisting of a light metal frame with spring clips for fastening to the reflector and one sheet each of red, blue, green and amber gelatin. The X-Ray "Color-Ray" is made up of two metal frames, between which is placed a sheet of color gelatin. The frames are held together by three split pins. The three spring clips mentioned above clip into the dimples of the reflector, thereby holding the color equipment firmly in place over the mouth of the reflector. This feature makes it very easy to change colors on a series of reflectors or replace burned-out lamps.

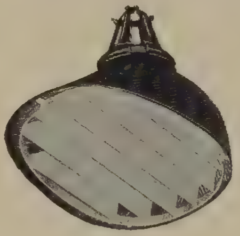
"Color-Ray" for Nos. 400, 410, 500, 510, 900 and 910.

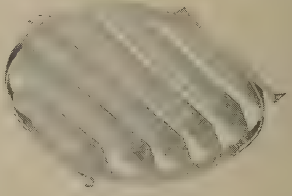
X-RAY COLOR EQUIPMENT

No.	For X-Ray Reflector
55	"King" No. 500 and "Queen" No. 510
440	"Jack" No. 400
441	"Jill" No. 410
99	"Giant" No. 900 and "Leviathan" No. 910

Window Reflector Louvers

When you are looking at a display in a corner window, the lamp filaments in the reflectors along the adjacent side may cause glare. In order to eliminate this objectionable feature, the reflectors may be equipped with louvers, which conceal the lamp filaments from view. For corner windows Type "N" louvers should be used, which have fins normal to the glass. For island windows, which present special problems, Type "P" louvers having fins parallel to the glass should be used.





Use Louver	For Reflector	Use Louver	For Reflector
No. 12400-N	No. 400	No. 12510-N	No. 510
No. 12410-N	No. 410	No. 12900-N	No. 900
No. 12500-N	No. 500	No. 12910-N	No. 910

All louvers are made of heavy gauge sheet iron fins, spot welded to a steel band. The louvers are held in the reflectors by means of spring clips inserted in the reflector dimples, which bring them flush with the bottom, as shown by the illustration above. The louver when clipped inside the reflector does not interfere with the use of color equipment or ceiling flange.

Show window showing louvers installed in reflector.

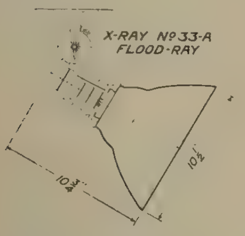
Show Window Floodlights

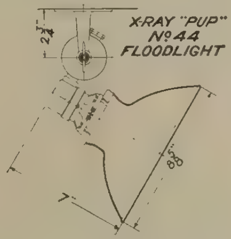
No. 44 "Pup" Show Window floodlight for use with a 100-watt A-23 Mazda lamp.

This floodlight with the center spot beam has been designed for use in small, narrow windows, art galleries, etc.

No. 33-A Show Window floodlight for use with a 200-watt PS-30 Mazda lamp.

This floodlighting unit is designed to give a smooth center spot beam for use in medium sized windows.

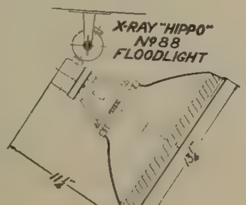




The two illustrations above show the overall dimensions of the No. 33-A and No. 44 show window lights.

No. 88 "Hippo" Show Window floodlight for use with a 500-watt PS-40 Mazda lamp.

The above cut shows the floodlight to be used in large show windows, also in windows using super-lighting. The illustration at the right shows the overall dimensions of the No. 88.



Auxiliary Equipment

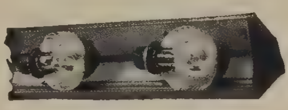
X-Ray "Control-Ring" is a circular spillshield for eliminating the spill of light common to all floodlights, and confining it to one straight controlled beam. It is attached by snapping the spring clips over the lip of the floodlight reflector and does not interfere with the use of color equipment.

Control Ring

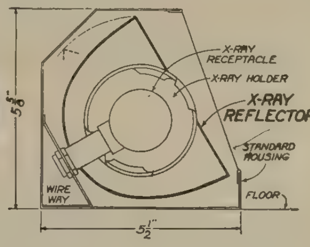
Control Ring	for Reflector
No. 13351	No. 33A
No. 18860	No. 88

Portable Footlights

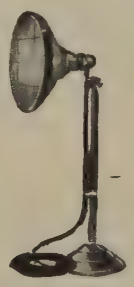
X-Ray Portable Footlights overcome shadows in the lower part of the window and show the display to good advantage. They are also used on stages in small auditoriums, schools, lodge rooms, etc. These units are made and stocked in standard lengths of 4 and 8 feet, finished in olive green, and are furnished in special lengths and finishes when specified.



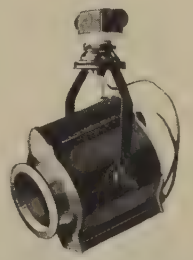
Portable Footlights



The X-Ray portable floodlight is the No. 88 floodlight mounted on a 54" portable iron stand with a heavy base. In addition to being portable, the universal adjusting feature of the floodlight permits the beam to be directed at any angle.



Portable Floodlight

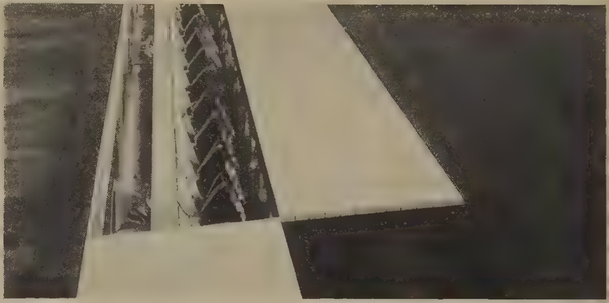


Spotlight No. 10307

X-Ray spotlight No. 10307 is used to concentrate a spot of light at close range where the general lighting is not intense. Changes in direction and size of the spot are made inside the unit. The beam of light can be focused from 12° to 20° by adjusting the lens.

CurtiStrip Installations

Covelighting installation showing X-Ray reflectors mounted on CurtiStrip. This wiring device makes a very rigid installation.

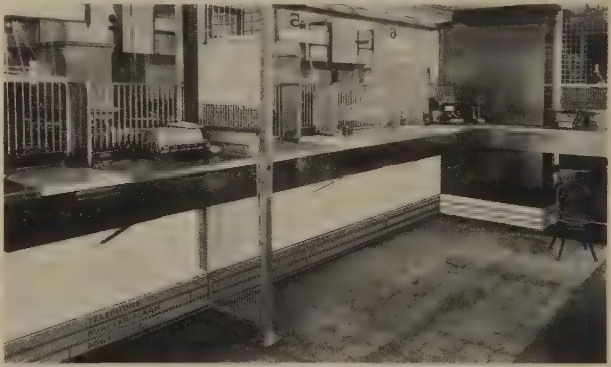


The above cut shows the way CurtiStrip is used to support reflector equipment in disappearing footlights for small stages.

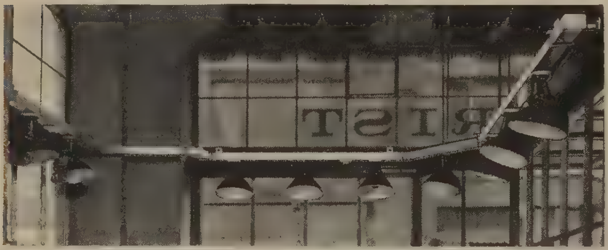
In this installation CurtiStrip has been used as a wiring device for the X-Ray show window reflector recessed in the ceiling.

The above illustration shows X-Ray reflectors mounted on CurtiStrip. These reflectors have been installed above a large skylight.

CurtiStrip provides a very neat and convenient method for supporting X-Ray reflectors above the show cases in this meat market.

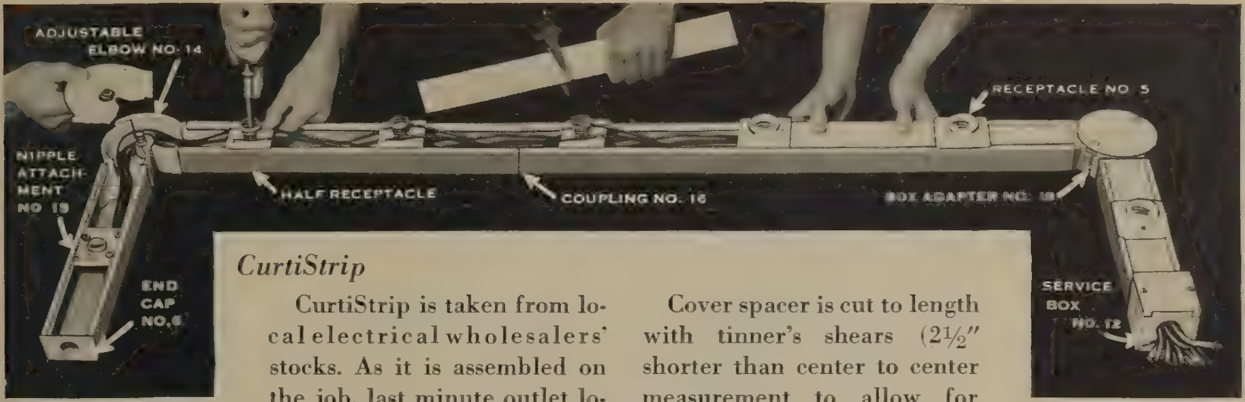


CurtiStrip may be used as a wiring device for systems other than lighting equipment. Here it is used for a burglar alarm system.



This florist shop shows the use of CurtiStrip to mount the reflectors on the transom bar. Note the bracket and adjustable elbow.

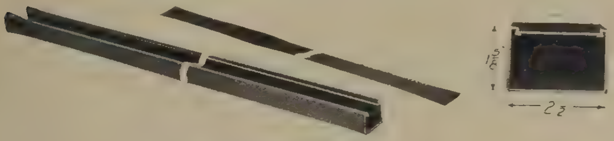
Another use of CurtiStrip as a wiring device is shown by the above illustration, where it is used for a number of hair dryers.



CurtiStrip

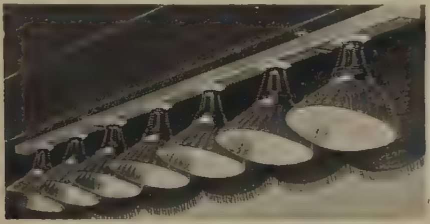
CurtiStrip is taken from local electrical wholesalers' stocks. As it is assembled on the job, last minute outlet location changes are easily taken care of. First receptacle bases are put in place and wired.

Cover spacer is cut to length with tinner's shears (2½" shorter than center to center measurement to allow for sockets). Cover is snapped in place.



No. 1 CurtiStrip
Shows channel and cover

This standardized wiring device approved by Underwriters Laboratories is applicable to all types of show window, cove installation and wherever a rigid metal wireway is required. Its use results in unusual labor and time saving with economical material cost.



Typical Show Window

CurtiStrip units assembled in lengths to fit, then installed completely wired. Any paint finish may be used. New receptacles may be added or rewiring done without tearing out installation (an exclusive CurtiStrip feature).

There are two methods of supporting CurtiStrip; one is by using the supporting strap as shown in the cut above, and the other by means of the bracket assembly.

Box Adapter

Super Lighting

Bracket Assembly horizontal use

Bracket Assembly vertical use

No. 5

No. 6

No. 9

No. 10

No. 12

No. 14

No. 16

No. 18

No. 19

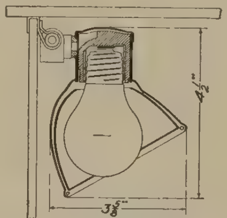
No. 19BX

Complete List of CurtiStrip Parts

CAT. No.	
No. 1.	CURTISTRIP — including cover.
No. 5.	PORCELAIN RECEPTACLE with shade holder groove.
No. 5A.	RECEPTACLE for X-Ray special type holder.
No. 6.	ENDCAP ½" knockout.
No. 9.	SUPPORTING STRAP (Use on approx. 5′ centers).
No. 10.	SUPPORTING BRACKET.
No. 12.	SERVICE BOX 4 - ¾" knockouts for multi-circuits, 2 screw removable cover.
No. 14.	ADJUSTABLE ELBOW 70° to 180°, removable cover.
No. 16.	COUPLING — Permitting use of all short lengths preventing waste.
No. 18.	BOX ADAPTER—used with standard 4" octagonal box to form cross T or L.
No. 19.	NIPPLE ATTACHMENT ⅜" female thread.
No. 19BX.	ATTACHMENT for BX.
No. 24.	BRACKET ASSEMBLY (In illustrations below).

Display Case Lighting Scoopette

X-Ray "Scoopette" No. S-200 is a small show case lighting unit equipped with an X-Ray Reflector. Standard inside frosted lamps are used. Scoopettes may be installed in any type of wood-frame or all-glass show case. The unit consists of X-Ray Reflector No. 720, metal housing, socket and socket cover. All metal parts are finished in black nickel.



S-200 SCOOPETTE UNIT

LAMPS

50 watt A-19 (rough service) Mazda
50 watt P-19 (mill type) Mazda
25 watt A-19 Mazda
15 watt A-17 Mazda

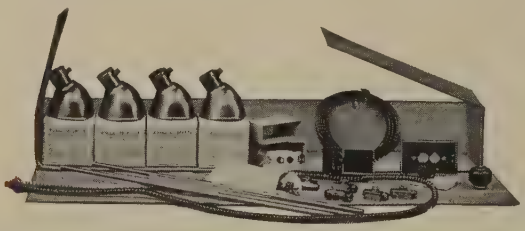
How to Plan Scoopette Lighting for Show Cases

The intensity of illumination in the show case should be considerably higher than the general illumination in the store in order to attract attention to the show case display. A "trim" of dark material requires a higher intensity than one of light colored material.

NUMBER OF SCOOPETTES ORDINARILY SUPPLIED

Length of Show Case in feet	3-5	5-7	7-9	9-11	11-13	13-15
Number of Scoopettes per case	2	3	4	5	6	7

The most satisfactory spacing for Scoopettes in the average show case is 24 inches. The 25 watt A-19 lamp is used and a uniform distribution of light over the entire case is provided. If the spacing is greater than 24 inches the illumination in the case may be uneven. If a higher intensity of light is desired, the Scoopette units can be placed closer together or the 50 watt A-19 (rough service) or P-19 (mill type) lamp can be used. For some types of displays, 15 watt A-17 lamps provide sufficient illumination. Since the 50, 25 and 15 watt lamps can be used in Scoopettes, the 24 inch spacing is recommended and varying intensities can be obtained by selecting the proper type of lamp.



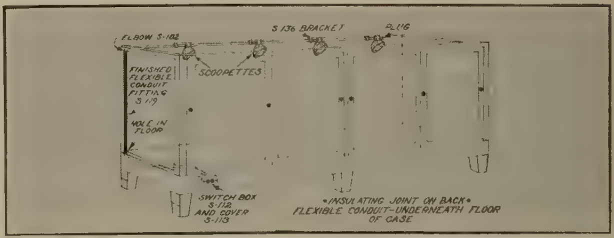
Most show cases are either 6 or 8 feet long. Scoopettes are furnished in standard outfits for such cases; Three-light outfits for 6-foot cases and four-light outfits for 8-foot cases. The complete equipment for one show case includes Scoopettes, tubing, fittings, switch and wire.

Method of Installing Scoopettes

The show case for stores are classified in two groups, namely, wood frame or all glass cases. In the installation of Scoopettes it is very necessary to know the type of case in order to supply the proper supporting brackets.

Wood Frame Cases

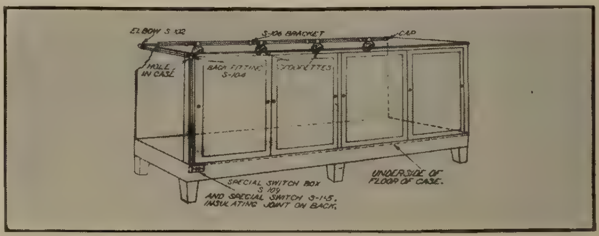
In "wood frame" cases where the plate glass top, front and sides are supported by a wood frame, the feed wires enter from underneath the floor of the case through a flexible conduit as shown in the diagram.


ELBOW S-102
S 136 BRACKET
PLUG
FINISHED FLEXIBLE CONDUIT FITTING S 119
SCOOPETTES
HOLE IN FLOOR
SWITCH BOX S-112 AND COVER S-113
•INSULATING JOINT ON BACK•
FLEXIBLE CONDUIT-UNDERNEATH FLOOR OF CASE

This flexible conduit extending from the switch at the back of the case to one of the front corners is concealed from view by one of the front corner posts. The connection between the front length of equipment and the flexible conduit is made with an elbow.

All Glass Cases

In "all glass" cases the plate glass top, front, and sides are either cemented together or held by small metal brackets. Feed wires are brought up through tubing on the back of one of the back posts. A cross tube then carries these feed wires to the front length of tubing. This method may be used for wood frame cases.

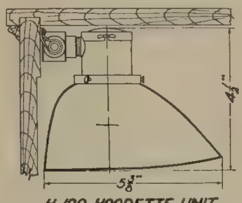

ELBOW S 102
S-106 BRACKET
CAP
HOLE IN CASE
BACK FITTING S-104
SCOOPETTES
UNDERSIDE OF FLOOR OF CASE.
SPECIAL SWITCH BOX S 109
AND SPECIAL SWITCH S-115.
INSULATING JOINT ON BACK.

Round End or Curved Show Cases

Many of the show cases in the modern stores of today have round ends, or the whole case may be curved. Where these conditions exist, the X-Ray Scoopette equipment may still be made to fit the cases. The tubing which connects the Scoopette units may be accurately bent to fit any shape case.

Hoodettes

X-Ray "Hoodette" No. H-199 is used for lighting wall cases, very small, shallow show windows, and large size show cases where the trim is low. The H-199 unit is of the concentrating type and includes an X-Ray reflector holder and socket with ⅜″ brass nipple. Metal parts are finished in black nickel, reflector in black enamel.



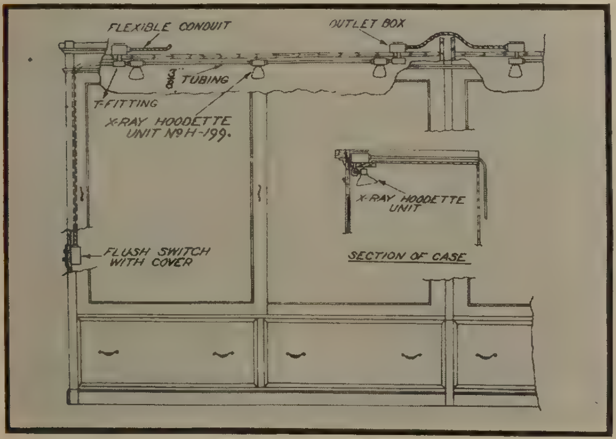
H-199 HOODETTE UNIT

LAMPS

50 watt A-19 (rough service) Mazda
50 watt P-19 (mill type) Mazda
25 watt A-19 Mazda
15 watt A-17 Mazda

Method of Installing Hoodettes

The same fittings used for installing Scoopettes are furnished on complete Hoodette outfits.


FLEXIBLE CONDUIT
OUTLET BOX
⅜ TUBING
T-FITTING
X-RAY HOODETTE UNIT NO H-199.
X-RAY HOODETTE UNIT
FLUSH SWITCH WITH COVER
SECTION OF CASE

Wall cases are always of wood frame construction but feed wires generally enter from an outlet on or near the top of the case as shown in the diagram.

A very satisfactory method of installation is to bring the feed wires through an outlet box and a connecting T fitting and down through flexible conduit to a switch installed near the base of the case.

When feed wires are brought up from underneath the floor of the case flexible conduit should be concealed behind one of the front corner posts or behind the case.

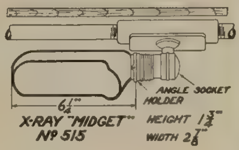
As shown by the diagram above, the connections between cases may be made by using a short section of flexible conduit connected to two outlet boxes located on the top of the case. The tubing for the Hoodette has been connected to the outlet box. It is not always necessary to make the connections on the outside of the cases. In several installations the flexible conduit was run through the partitions between cases and connected directly to the Hoodettes.

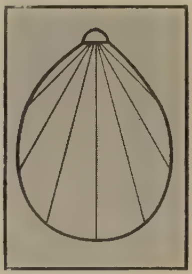
Midget

X-Ray "Midget" No. 515 lights small display cases, pictures, small coves, etc. This reflector is used where installation space is limited and where it is desired that the lighting equipment be inconspicuous. Its special X-Ray holder fits any brass shell socket.

HOLDER
Special X-Ray holder included

LAMP
25 watt tubular Mazda

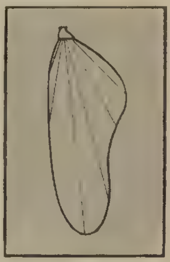

6¼"
ANGLE SOCKET HOLDER
X-RAY "MIDGET" No 515
HEIGHT 1¾"
WIDTH 2⅞"



No. 7 "Scoop Junior" and No. 11 "Hood Junior"

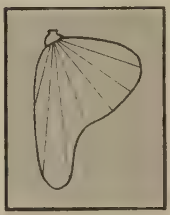
The "Scoop Junior" reflector is used in deep show windows less than five feet high, and in large deep display cases. The "Hood Junior" reflector is used in shallow show windows less than five feet high, and in large shallow display cases. These reflectors are used where space for installing is limited and where it is essential that the view of the display be unobstructed.

"Hood Junior" No. 11

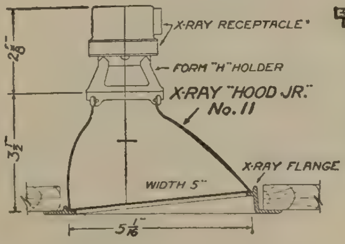


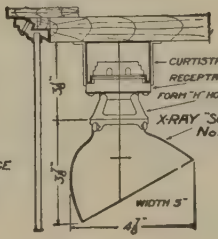
HOLDERS	LAMPS
Form H 2¼″	60 watt A-21 Mazda
Form H 2¼″	50 watt A-21 Mazda
Form O 2¼″	40 watt A-21 Mazda
Form O 2¼″	25 watt A-19 Mazda

"Scoop Junior" No. 7



Methods of Installing


X-RAY RECEPTACLE
FORM "H" HOLDER
X-RAY "HOOD JR." No. 11
X-RAY FLANGE
WIDTH 5"
2⅝"
3½"
5 1/16"


CURTISTRIP RECEPTACLE
FORM "H" HOLDER
X-RAY "SCOOP JR." No. 7
WIDTH 5"
3⅜"
3⅞"
4⅞"

Description of X-Ray Projectors

X-Ray projector No. 49 is an extra heavy gauge steel unit for outside use where long throws of light are required. It has a cast trunion base with a universal adjustment and a simple focusing device. The base is 10″ in diameter and has four ⅝″ holes on an 8½″ diameter. The clear deep bowed heat resisting cover glass presses into a cork gasket around the housing making it water-tight. There are seven latch bolts for holding the cover secure. The housing is finished with an electrolytic coating of Udylite which prevents rust and corrosion. This projector may be equipped with color lenses which fit inside the front cover as will be noted by the list of projector fittings for the No. 49 shown on this page. The projector is equipped with No. 841 X-Ray silver mirrored reflector for use with a 1500, 1000, 750-watt PS-52 standard lamp.

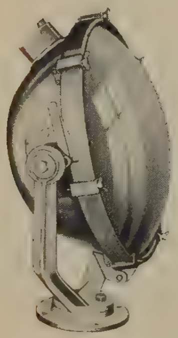
The No. 409 projector is a copper unit of the same construction.

The No. 37 or 25 X-Ray projectors are made of heavy gauge steel. They have double control bases with universal adjustments and a simple lamp focusing device. The base for the No. 37 is 5″ in diameter with four ½″ holes on a 3½″ diameter. The base for the No. 25 is 2″ x 4″ with two ½″ holes 2¾″ on center.

The clear deep bowed heat resisting cover glasses press into a cork gasket around the housing making them water-tight. Five latch bolts are used on the No. 37 to hold the cover secure, while there are three latch bolts on the cover of the No. 25 projector. The housings are furnished in a Udylite finish which prevents rust and corrosion. These projectors may be equipped with color lenses as shown on pages 306-307.

The No. 37 projector may be equipped with either the No. 831 concentrating or No. 833 distributing reflectors as shown on this page. The No. 25 projector has two reflectors available, the No. 821 concentrating or the No. 823 distributing. See page 307.

The No. 307 or 205 projectors are copper units of the same construction.



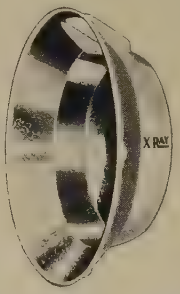
Floodlighting Projectors

No. 49 SUN PROJECTOR LAMP

1500-1000-750 Watt PS-52 Mazda

Diameter 23″. Depth 14¾″. Height 31″.
No. 49-C (Steel) X-Ray Reflector No. 841 Beam spread 15°-25°.
No. 409-C (Copper) X-Ray Reflector No. 841. Beam spread 15°-25°.

No. 49 Sun Projector Parts

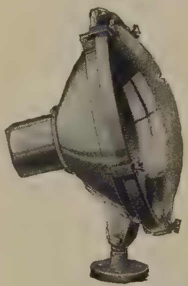


X-Ray Reflector No. 841

X-Ray Projector "Sun" Nos. 49 and 409 are furnished with X-Ray Reflector No. 841.

No. 49 PROJECTOR FITTINGS

No. 10543	Hammered lens with one-half sanded.
No. 10544	Clear hammered inside lens.
No. 10545	Ruby inside color lens.
No. 10546	Amber inside color lens.
No. 10547	Green inside color lens.
No. 10548	Blue inside color lens.
No. 10549	Clear outside cover glass.
No. 10550	Rectangular beam outside lens.



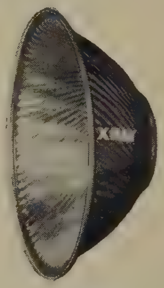
No. 37 "MOON" PROJECTOR LAMP*

500 watt G-40 Mazda floodlighting lamp.

Diameter 17⅛″. Depth 13⅝″. Height 20¾″.
No. 37-C (Steel)—X-Ray Reflector No. 831. Beam spread, 10-20°.
No. 37-E (Steel)—X-Ray Reflector No. 833. Beam spread, 30-60°.
No. 307-C (Copper)—X-Ray Reflector No. 831. Beam spread, 10-20°.
No. 307-E (Copper)—X-Ray Reflector No. 833. Beam spread, 30-60°.

No. 37 Moon Projector Parts

X-Ray Reflector No. 831



X-Ray Reflector No. 833

X-Ray Projector "Moon" Nos. 37 and 307 are regularly supplied with X-Ray Reflector No. 831; X-Ray Reflector No. 833 is substituted when specified.

No. 37 PROJECTOR FITTINGS

No. 10533	Ruby inside color lens.
No. 10534	Amber inside color lens.
No. 10535	Blue inside color lens.
No. 10536	Green inside color lens.
No. 10537	Clear outside cover glass.
No. 10538	Hammered clear inside lens.
No. 10539	(Steel) Sleeve extension for adapting No. 37 to Standard 500-300 Watt PS40 lamp.
No. 10539-C	(Copper) Same for No. 307.
No. 10541	Rectangular beam outside lens.
No. 10637	Control Ring.

No. 25 "STAR" PROJECTOR LAMP*

250 watt G-30 Mazda floodlighting lamp

Diameter 13". Depth 12". Height 16½".
No. 25-C (Steel)—X-Ray Reflector No. 821. Beam Spread, 10-20°
No. 25-E (Steel)—X-Ray Reflector No. 823. Beam spread, 30-50°.
No. 205C (Copper)—X-Ray Reflector No. 821. Beam spread, 10-20°.
No. 205-E (Copper)—X-Ray Reflector No. 823. Beam spread, 30-50°.

*Floodlighting lamps are not to be burned within an angle of 45° base up.

No. 25 Star Projector Parts

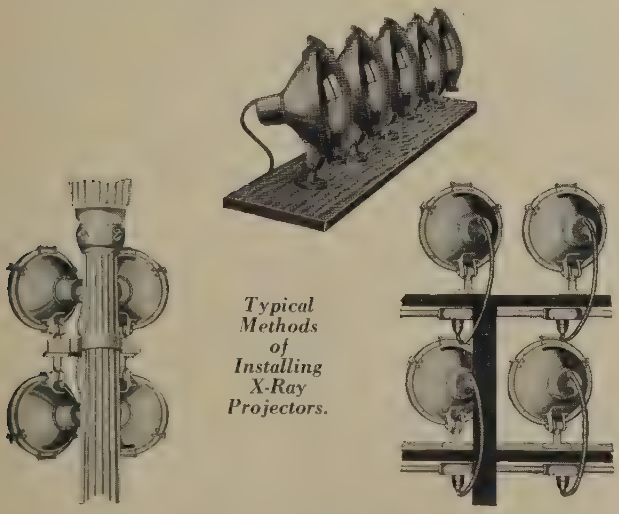
X-Ray Reflector No. 821

X-Ray Reflector No. 823

X-Ray Projector "Star" Nos. 25 and 205 are regularly supplied with X-Ray Reflector No. 821; X-Ray Reflector No. 823 is substituted when specified.

NO. 25 PROJECTOR FITTINGS

No. 10521	Ruby inside color lens.
No. 10522	Amber inside color lens.
No. 10523	Blue inside color lens.
No. 10524	Green inside color lens.
No. 10525	Clear outside cover glass.
No. 10526	Clear Hammered inside lens.
No. 10527	(Steel) Sleeve extension for adapting No. 25 to Standard 200 Watt Mazda lamp.
No. 10527-C	(Copper) Same for No. 205.
No. 10529	Rectangular beam outside lens.
No. 13351	Control Ring.



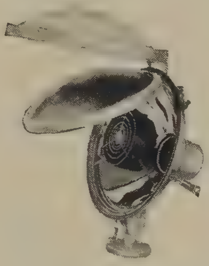
Typical Methods of Installing X-Ray Projectors.

Floodlighting

There are many different purposes of floodlighting. It may be used as an advertising medium, for office buildings, theatres, industrial plants, stores or banks. Or in the case of churches, fountains, public buildings, monuments or any type of building design, it may be used as a means of producing artistic effects. Beaches, playground, stadiums, railroad yards, docks, etc., are other uses of floodlighting equipment.

Buildings may be lighted two different ways. One by flooding the entire building with a uniform illumination without sharp shadows. The light is directed so as to give the building a night-time appearance very nearly the same as in the daytime. Buildings which have a very simple treatment and were designed strictly for the utilitarian purpose should be lighted in this manner.

The other method of floodlighting is the use of equipment properly located on the building to produce different shadow effects. This scheme can be easily worked out with our more modern buildings which have set back features, towers, or columns.



Color Equipment and Control Ring Installed in X-Ray Projector.

Control Ring

The columns of a building may be floodlighted by two ways. The fronts may be lighted so they stand out in contrast with the recessed areas on each side. Or they may be lighted from the back which causes them to stand out in silhouette against the lighted background.

Floodlighting Calculation

The choice of floodlighting projectors depends upon the location of the units with respect to the surface to be lighted and the total area being lighted.

The different types of floodlights shown on pages 306-307 may be classified according to the beam spread.

Narrow beam—10°-15°
Medium beam—15°-30°
Broad beam —30°-60°

The total lumens in the beam of floodlighting projectors vary from 30 to 40% of the total lumen output of the lamp. This depends upon the type of lamp used whether floodlighting or general service. The floodlighting lamp will have the greater per cent of lumens in the beam.

Taking the average beam lumens as 35 per cent of the lamp lumens, the number of projectors may be figured by using the following formula:

$$\text{number of projectors} = \frac{\text{area x foot-candles}}{0.7 \text{ x beam lumens}}$$

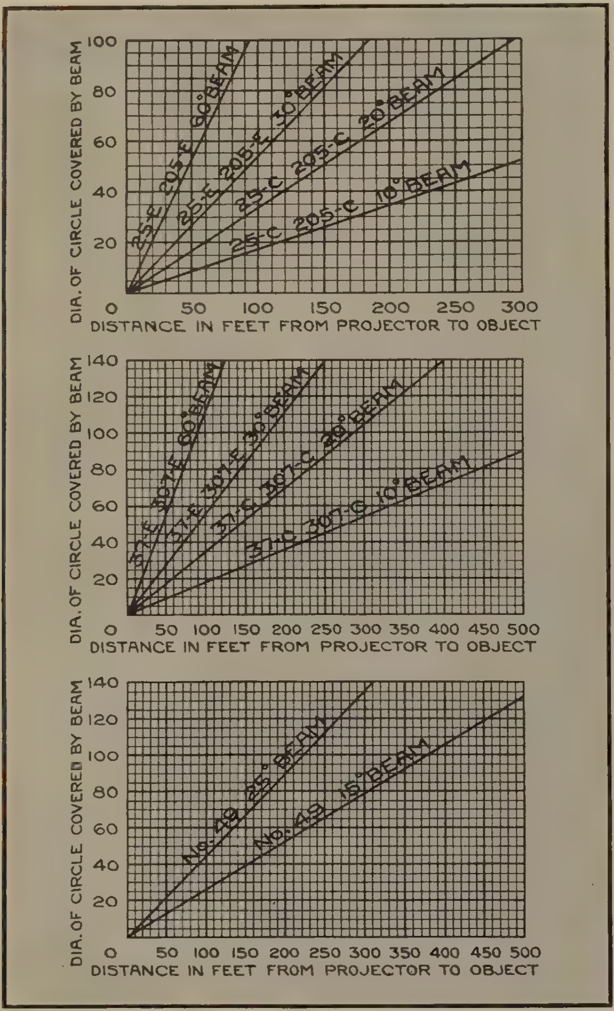
area = area of surface to be lighted.
foot-candles = intensity desired shown in table 8 page 308.
0.7 = Allowance for 30 per cent depreciation.

As a check for coverage the following formula should be used:

$$\begin{array}{l}\text{Number of}\\ \text{projectors}\\ \text{for coverage}\end{array} = \frac{\text{area of lighted surface}}{\begin{array}{c}\text{average area lighted effectively by}\\ \text{each projector}\end{array}}$$

To determine area covered by projector, use graphs shown below.

Graphs Showing Distribution of Beams from Projectors



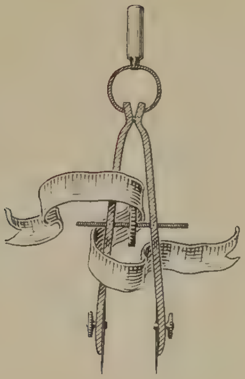
These areas apply only when projectors are placed so that beam is perpendicular to surface lighted.

When the beam of light from the projector strikes the surface perpendicularly it illuminates a circular area with practically a uniform distribution.

If the beam is directed to the surface at an angle it illuminates an area which is elliptical in shape. The greater the angle at which the beam strikes, the larger becomes the area of the ellipse and the portions of the field nearest the projector are brightest.

TABLE No. 8
Foot-Candles Illumination for
OUTDOOR LIGHTING

	Foot-Candles Recommended
Automobile Parking Spaces	1
Baseball Diamond (Indoor Game)	10
Basket Ball	6
Bathing Beaches	1
Boxing:	
Seats	3
Ring	80
Building:	
Construction Work	6
Excavation	2
Building Exteriors and Monuments—Floodlighted:	
Bright Surroundings—	
Light Surface	10
Dark Surface	20
Dark Surroundings—	
Light Surface	6
Dark Surface	12
Church Windows (Art Glass)	25–50
Circus:	
Seats	3
Arena	10
Clock Golf	10
Croquet	6
Dredging	2
Drill Fields	3
Flags—Floodlighted	25–50
Football:	
Practice	6
Games	12
Gasoline Filling Stations:	
At Pumps	15
Yard and Driveways	4
Horseshoe Pitching	6
Ice Hockey	8
Loading Docks	3
Lumber Yards	1
Motordromes:	
Seating	3
Track	15
Monuments (See Building Exteriors)	
Piers:	
Freight (See Loading Docks)	
Passenger	4
Playgrounds	4
Polo	8
Prison Yards	3
Protective Industrial	1
Quarries	3
Railway Yards:	
General	0.25
Scale House	3
Roque	6
Ship Yard Construction	6
Skating	2
Storage Yards	1
Swimming Pools	5
Target Shooting	20
Tennis Court	25–50
Toboggan Slides	2
Traffic Officers	20
Trap Shooting	15
Volley Ball	15



LIGHTING DATA AND TABLES

Illumination Terms

Absorption—the loss which results when light strikes any objects or traverses any medium.

Angle of Incidence—The angle which a ray of light striking a surface makes with the normal to that surface.

Angle of Reflection—The angle with respect to the normal at which a ray of light leaves a surface after it has been reflected.

Apparent Candle-Power—It is customary to designate the light intensity of an illuminant in apparent candle power measured as some designated distance in cases where, because of the relatively large area of the light source, or the use of certain lenses or reflectors, the Law of Inverse Squares does not apply, and where, as a consequence, the intensity of light cannot be accurately stated in candle power.

Beam Candle-Power—The candle power of a beam in any given direction within the beam limits.

Brightness—Any object emitting or reflecting light is said to be bright and, because of its brightness, is visible.

Candle-Power—Candle-power is a measure of luminous intensity, a term used to express the intensity of light emanating in any given direction from a light source. It is analagous to steam pressure in steam engineering and voltage or electromotive force in electrical engineering.

Coefficient of Absorption—This absorption factor is the ratio of the amount of light absorbed by a body to the amount of light falling upon it.

Coefficient of Reflection—The ratio of the total light reflected by a surface to the total light falling upon it. In the case of mixed regular, and diffuse reflection the coefficient may be divided into its component parts.

Coefficient of Transmission—The ratio of the total light transmitted to the total light falling upon a surface.

Color—Color is the sensation produced in the eye by reason of the wave lengths or rate of vibration of the light rays. The true color of a body is its daylight color. The apparent color may change when the body is illuminated with light of different colors. The color of different objects is generally due to their ability to absorb certain wave lengths of light and reflect others: for example, a body which absorbs red rays and reflects blue and yellow rays appears green.

Cove Lighting—A system of indirect lighting in which lamps and reflectors are concealed by a molding or other suitable structural element around the edge of the area to be illuminated. The light is directed to the ceiling from which it is diffused.

Diffusion—Light is said to be diffused when by process of reflection and refraction it reaches the eye from many directions rather than from one direction of the source.

Dimmer—A variable resistance connected in series with incandescent lamps to reduce the brightness or the light output to a desired value.

Direct Lighting Unit—A lighting unit which emits the major portion of its flux in such a manner that it reaches the area to be illuminated without redirection or reflection.

Distribution Curve—A polar diagram showing graphically the distribution of light given out by a source.

Efficiency of Lamps—Lamp efficiency is expressed in terms of the ratio of lumens output to power input. The rated efficiency of Mazda lamps is now expressed in lumens per watt.

Efficiency of Utilization—The percentage of total lumens emitted by the lamp that reaches the working plane.

Effective Lumens—The total number of lumens falling on the working plane. This value may be obtained by multiplying the area of the working plane by the average illumination in foot-candles.

Effective Lumens per Watt—The effective lumens of a given area divided by the total watts of the lamp illuminating the area is called effective lumens per watt.

Enclosing Unit—In the ordinary use of the term a direct-lighting unit in the form of a diffusing globe entirely surrounding the light source.

Filament—A conductively continuous light giving element which becomes incandescent due to its resistance to passage of current through it.

Foot-Candle—The unit of intensity of illumination. It is equal to the illumination falling upon a surface one foot distant from a one candle-power source. If a uniform point source of one candle-power is placed at the center of a sphere of one foot radius, every point on the inner surface of the sphere receives an illumination of one foot-candle. This is apparent from the fact that the area of this unit sphere is 12.57 square feet, and a uniform point source of one-candle-power emits 12.57 lumens. Hence, one lumen per square foot gives an average intensity of one foot-candle.

Glare—Glare is a condition of bright light sources or illuminated surfaces which results in ocular discomfort or interference with vision.

Hue—Hue is that property of color by which the various spectral regions are characteristically distinguished. All colors except purples and whites may be matched in hue with spectral colors. In the case of a purple, the spectral hue which is complimentary to the hue of purple is ordinarily used for scientific designation.

Illumination—The term illumination is often used to indicate the luminous radiation falling upon a surface in contradistinction to light as luminous radiation emitted from a light source. The intensity of illumination is measured in foot-candles and flux of illumination in lumens.

Illuminometer—An instrument used for measuring the intensity of illumination. This instrument is sometimes called a portable photometer.

Indirect Lighting Unit—A lighting unit which emits practically all of the light flux upward to the ceiling for diffuse reflection over the room area. The ceiling or its equivalent then becomes a secondary source of low brightness and large area, which provides an even illumination of a diffuse nature and free from glare.

Intensity—A measure of luminous radiation in any direction without reference to area. Intensity of light is measured in candle-power and the intensity of illumination in foot-candles.

Lambert—The lambert is the unit of brightness. It is the brightness of a perfectly diffusing surface radiating or reflecting one lumen per square centimeter. This is equivalent to a perfectly diffusing surface having a reflection factor equal to unity. For most purposes the millilambert, equal to 1-1000 of the lambert, is the preferable practical unit.

A perfectly diffusing surface emitting one lumen per square foot will have a brightness of 1.076 millilambert.

Brightness expressed in candles per square centimeter may be reduced to lamberts by multiplying by 3.14.

Brightness expressed in candles per square inch may be reduced to lamberts by multiplying by 0.487.

Law of Inverse Squares—Unless modified by some interfering agency, light rays travel in straight radial lines in all directions from the source. The law of inverse squares follows directly from the fact: The intensity of illumination received by a surface from a light source, is directly proportional to the candle-power, and is inversely proportional to the square of the distance. For instance, at one foot from a lamp giving 16 candle-power the intensity would be 16 foot-candles; at 2 feet, 4 foot-candles, and at 4 feet, one foot-candle.

Light Distribution Curves—The intensity of light in candle-power from a source is indicated by a light distribution curve. The intensities corresponding to various angles of emission, about either the horizontal or vertical axis, are plotted in polar coordinants.

Louvre—A shield which is placed in the path of light to eliminate a part which is not desired.

Lumen—The lumen is the unit of flux of light or illumination. The flux required to light a given surface is proportional to the illumination and the area of the surface. One lumen will light a surface of one square foot to an average of one foot-candle intensity. The number of lumens required to light a surface to any given illumination is equal to the product obtained by multiplying the area of the surface in square feet by the average foot-candles which it is desired to produce. For a light source the total number of lumens delivered equals the mean spherical candle-power multiplied by 12.57.

Lumens per Watt—The efficiency of an incandescent lamp may also be expressed as lumens per watt. Lumens per watt equals lumens divided by watts.

Effective lumens per watt is a measure of the efficiency of a lighting installation and equals the total effective lumens divided by the total watts input of all units, equals mean foot-candles divided by watts per square foot.

Mean Spherical Candle-Power—The average candle-power of a lamp in all directions in space. The mean spherical candle-power bears a definite relation to the total flux of light from the lamp, and is, therefore, sometimes used as a measure of that quantity.

Opaque—Impervious to light rays. The quality of an object or machine that prevents the transmission of light.

Optiphosis—Any defect of vision, ailment of the eye, or pathological disarrangement in the sight which is caused by light is classified under the term optiphosis.

Photometer—A photometer is a device used to compare the candle-power of different light sources.

Photometric Curves—(See Distribution Curves.)

Projector—A device for projecting light. Since the term is used in a number of different senses, the type of projector referred to should always be mentioned, as motion picture projector, floodlighting projector.

Reflector—A reflector redirects the light from the lamp so that it may be utilized most efficiently and conceals the lamp so that the eye is protected from the intense brilliance of the filament.

Regular Reflection—Regular or specular reflection occurs when a beam of light falls upon a highly polished surface. The familiar law, the angle of incidence is equal to the angle of reflection, applies to this type of reflection.

Spectrum—Daylight and artificial light may be broken up into their various component parts or colors by means of a prism. The arrangement of colors produced by this analysis is called the spectrum. The principal colors of the spectrum are violet, blue, green, yellow, orange, and red.

Specular Reflection—(See Regular Reflection.)

Transmission—Transmission may be defined as the passage of light through an object or medium.

Visual Acuity—The ability of the eye to distinguish fine detail. Visual acuity, for example, is the measure of ability to read type, etc.

Working Plane—The working plane or plan of reference is the plane on which the work is performed and which, therefore, must be adequately and satisfactorily illuminated.

Wattage Rating—Lamp sizes for interior illumination are now most commonly given in the watts consumed when operated at their rated voltage.

EFFECT OF COLORED LIGHTS ON VARIOUS COLORS

ORIGIONAL COLOR OF FABRIC	COLOR OF LIGHT FALLING ON FABRICS					
	RED	ORANGE	YELLOW	GREEN	BLUE	VIOLET
BLACK	Purplish Black	Deep Maroon	Yellow Olive	Greenish Brown	Blue Black	Faint Violet Black
WHITE	Red	Orange	Light Yellow	Green	Blue	Violet
RED	Intense Red	Scarlet	Orange	Brown	Violet	Red Violet Purple
ORANGE	Orange Red	Intense Orange	Yellow Orange	Faint Yellow slightly Greenish	Brown slightly Violet	Light Red
YELLOW	Orange	Yellow Orange	Orange Yellow	Yellowish Green	Green	Brown tinged with Faint Red
LIGHT GREEN	Reddish Gray	Yellow Green	Greenish Yellow	Intenser Green	Blue Green	Light Purple
DEEP GREEN	Reddish Black	Rusty Green	Yellowish Green	Intenser Green	Greenish Blue	
LIGHT BLUE	Violet	Orange Gray	Yellowish Green	Green Blue	Vivid Blue	
DEEP BLUE		Gray slightly on Orange	Green Slate	Blue Green	Intenser Blue	Bright Blue Violet
INDIGO BLUE		Orange Maroon	Orange Yellow (Very Dull)	Dull Green	Dark Blue Indigo	Deep Blue Violet
VIOLET	Purple	Red Maroon	Yellow Maroon	Bluish Green Brown	Deep Bluish Violet	Deep Violet

Table showing effect of colored lights on various colors.

THESE COLORS WHEN MIXED	MAKE
Black and Red	Brown
Black and Venetian Red	Chocolate
Blue•Red and White	Lavender
Blue and Lead Color	Pearl
Blue and Yellow	Green
Green and Yellow	Pea Green
Indigo and Lamp Black	Silver Gray
White•Vermillion and Carmine	Pink
White•Yellow and a little Vermillion	Cream Color
White and Lamp Black	Lead Color
White and Red	Brown
White and Yellow	Straw Color

Table showing the results obtained by color grouping.

COLOR	HARMONIZES WITH
Brown	Orange•Cardinal
Brown	Turquoise•Mauve•Gray
Cardinal	Turquoise•Marine•Blue
Crimson	Green
Garnet	Sapphire•Mauve•Pearl
Gray	Violet•Crimson•Lavender
Heliotrope	Cream
Lavender	Green
Mauve	Emerald•Dark Brown•Garnet
Orange	Violet•Light Blue•Indigo
Old Rose	Any Shade of Blue
Pink	Light Blue
Purple	Orange
Red	Blue•Gray•Green
Rose	Light Blue
Scarlet	Ecru•Light Blue
Violet	Light Green•Dark Green
Yellow	Violet•Blue•Green

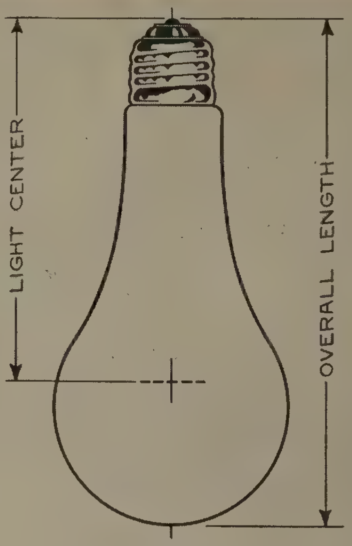
Table showing combination of colors for color harmony.

Table No. 9

LUMEN DATA FOR STANDARD MAZDA LAMPS

Voltage-115

Watts	Bulb	Rated Lumens	Lumens per W.	Lgt. Service	Screw Base	Overall Length	Light Center	Burning Position
15	A-17	132	8.8	Dec.	Med.	3 5/8"	2 3/8"	Any
25	A-19	242	9.7	Gen'l	Med.	3 15/16"	2 1/2"	Any
25	T-10	225	9.0	Lim.	Med.	5 5/8"	~~~~	Any
40	A-21	412	10.3	Gen'l	Med.	4 7/16"	2 7/8"	Any
50	A-19	445	8.9	R.S.	Med.	3 15/16"	2 1/2"	Any
50	A-21	540	10.8	Gen'l	Med.	4 15/16"	3 3/8"	Any
60	A-21	690	11.5	Gen'l	Med.	5 1/4"	3 3/4"	Any
100	A-23	1360	13.6	Gen'l	Med.	6 1/16"	4 3/8"	Any
150	PS-25	2295	15.3	Gen'l	Med.	6 15/16"	5 1/4"	Any
200	PS-30	3340	16.7	Gen'l	Med.	8 1/8"	6"	Any
250	G-30	3575	14.3	Flood	Med.	5 1/8"	3"	Base Down
300	PS-35	5370	17.9	Gen'l	Mog.	9 7/16"	7"	Any
500	PS-40	9650	19.3	Gen'l	Mog.	9 13/16"	7"	Any
500	G-40	8300	16.6	Flood	Mog.	7 1/16"	4 1/4"	Base Down
750	PS-52	14550	19.4	Gen'l	Mog.	13 1/8"	9 1/2"	Any
1000	PS-52	20200	20.2	Gen'l	Mog.	13 1/8"	9 1/2"	Any
1500	PS-52	32400	21.6	Gen'l	Mog.	13 1/8"	9 1/2"	Any



MAZDA LAMPS
MARCH-1929

Table No. 10

Length of run from Panel Box to Outlet in Feet.	Watts Per Circuit						
	800 to 1000	1000 to 1200	1200 to 1500	1500 to 1800	1800 to 2200	2200 to 2600	2600 to 3000
30 or less	14	14	14	12	12	10	10
30-45	14	12	12	10	10	10	8
45-60	12	12	12	10	8	8	8
60-80	12	10	10	8	8	6	6
80-100	10	10	8	8	6		
100-120	10	8	8	6			
120-150	8	8	6				
150-200	8	6					

Table No. 11

Light Transmission of Glass

Types of Glass	Transmission Factors
Clear Hammered	90-95 %
Clear Sanded Hammered	70-85 %
Clear Pebbled	65-80 %
Amber Hammered	70-75 %
Sanded Amber Hammered	50-60 %
Clear Antique	85-90 %
Amber Antique	75-80 %
Sanded Amber Antique	55-70 %
White Opal	35-50 %
Flashed Opal	55-60 %

Table No. 12

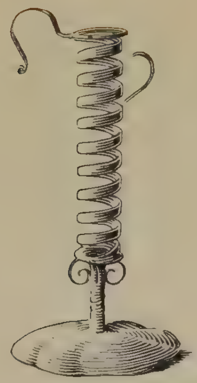
Reflection Factor of Metal Surfaces

Metal Surfaces	Reflection Factors
Porcelain Enameled Metal	74 %
Aluminum Sheets	68 %
Cadmium Plated Metal	64 %
Chromium Plated Metal	64 %
Monel Metal	49 %
Nickel Plated Metal	63.5 %
Nickeloid	71 %
Silver Plated Metal	90.5 %
Silver Glass Mirror	93 %

Table No. 13

Reflection Factor of Paint Finishes

Colored Surfaces	Reflection Factors
Flat White	82 %
Ivory White	78 %
Cream	74 %
Caen Stone	70 %
Ivory Tan	65 %
Light Gray	60 %
Buff	55 %
Tan	40 %
French Gray	35 %



INDEX

Absorption—55, 309
  coefficients—312
  of glass—312
  of paint finishes—312
  of metal surfaces—312
Adapter for Curtis indirect portable lamp—201, 286
Adequate wiring—278
Altar lighting
  churches—108, 295
  lodges—170
Amusements, floodlighted—231
Angle of incidence—309
Angle of reflection—309
Apparent candle-power—309
Applications of floodlighting—232, 243
Applications of X-Ray indirect lighting—69, 110, 277, 284, 310
Arcade lighting—189
Architect's drafting room—215
Arenas—229
Armories—279, 293
Art museums—157, 279
Artistic aspect of lighting—49
Assembly department, industrial—279
Assembly halls—147
Athletics—218
Athletic grounds, floodlighted—308
Auditorium—130
  of church—110
  of theatre—120
  cove lighting—130
Automobile show room—102, 253, 279
Automobile manufacturing—280
Automobile parking space—308
Automobile accessory shop—103

Ballroom—228
Band stand floodlighting—242
Bank cage, local lighting with Brackette—89, 279, 289
Bank cove lighting—289
Bank—78, 289
  check desk lighting—86
  lighting without ceiling fixtures — 83, 286, 289
  lighting through skylight—82
  of floodlights—234
  partition lighting—289
  tellers' cages—88
Banking room, indirect brackets—83, 289
Bank-Ray—88, 290
Baptistry lighting—116
Barber shop—264, 279
Brightness—309
Baseball, indoor game—220, 279, 308
Basket ball—220, 279, 308
Bathing beaches—308
Beam candle-power—309
Bed room—205
Best light for the eyes—46, 284
"Betty" lamp—19
Billiard rooms—223
Billiard table—223, 293
Bookrack lighting with "Scoopette"—155
Bookstacks in library—155
Bowling alleys—279, 293
Brackets for indirect lighting—289
Brackette—289

Cafe—185
Cafeteria—183
Calculations—277 to 308
  for high bay direct lighting—291
  for floodlighting—307
  for indirect lighting (office)—284
  for show windows—298
Candles—18, 20
Candle-power—309
Candy shop lighting—98, 256
Candy shop windows—256
Capitol Building—137, 140
Cashier's cage—289
Ceiling flanges—300
Ceiling, color for indirect lighting—284
Chancel and sanctuary—108
Chemical laboratories—210
Children's room, hospital—194
China store—101
Churches—107
  altar lighting—108, 295
  art glass windows—117, 295, 308
  auditoriums—106, 110, 279
  chancel lighting—108
  concealed lighting—106, 112
  direct lighting—111, 294
  floodlighting—238
  luminaires for—118, 119
  nave—110
  sanctuary—108
  stations of the cross—117, 295
  Sunday school room—116, 279
City Hall Building—136
Civic auditorium—131
Class rooms, schools—143
Clubs—165
  ballrooms—167, 178
  billiard rooms—223, 293
  bowling alley—223, 279, 293
  dining rooms—167, 177, 180, 182
  gymnasiums—219, 279, 293
  handball courts—224, 279, 293
  library—150
  lounge—166, 170, 279
  reading room—152, 165, 279
Coefficients
  of absorption—309, 312
  of reflection—309, 312
  of transmission—309, 312
  of utilization table—281
Conference rooms—76
College, gymnasiums—220, 279, 293
College, libraries—151
Color—309
Color in lighting—54, 286
  Lumitone—56
Color of ceilings for indirect lighting—284
Colors, effects of colored lights on—311
Complimentary colors—54
Clothing store windows—249
Clubs—165
Column clusters
  auto showrooms—102
  for indirect lighting—102, 286
Conserving eyesight—48
Consistories—172
Control ring—301, 307
Cooperating with the architect—62
Corridors, hospital—288
Court room—139, 141, 279
Court, squash racquet—224, 279, 293
Court, tennis—226, 279, 308
Cove lighting—115, 286, 309
Cove lighting reflectors—285
Curtis adapter—201, 286
Curtis Lighting, Story of—25
CurtiStrip—303

Data on illumination—309 to 312
Definitions of lighting terms—309
Dental offices—279
Department store—100, 250
Depot waiting rooms—191, 279

- Desk lighting for bank cages—290
- "Deskette"—289
- Diamond Cutlery—210
- Diffusion—309
- Dining room—177, 180, 204
  - hotel—177
- Direct lighting
  - spacing and hanging distances—278, 291
  - general requirements—291
  - in church—111, 294
  - intensities recommended—280
  - planning—291
  - reflectors—292
- Direct lighting units—309
- Disappearing footlights—129
- Display booth—92
- Display cases—259
- Display case lighting—259, 260, 304
  - department stores—258, 262
  - general stores—258
  - electrical shop—261
  - jewelry stores—262
- Display rooms—91
- Display window lighting—245, 296
- Distribution curve—309
- Drafting rooms—215, 279
- Drill fields—308
- Drill hall—293
  - armory—293
- Dust cover for luminous bowl fixtures—66, 75

- Economic value of lighting—64
- Edison's lamp—22
- Educational buildings—143
- Effect of light on eye—43
- Efficiency of lamps—309
- Efficiency of utilization—281, 310
- Effective lumens—310
- Effective lumens per watt—310
- Electrical shops—104, 255, 261
- Elevator lobby—188
- Enclosing unit—310
- Engineered lighting—35
- Equipment for indirect lighting—285
- Exhibition rooms—159
- Exhibits—271
- Exposition rooms—159
- Eye—42
  - best light for—43
  - defects—44
  - diseases of the—44
  - effect of intensity on efficiency of—43
  - effect of light—43
  - efficiency, Ferree test for—46
  - structure of—42

- Factories—207
- Ferree test for eye efficiency—46
- Field houses—219, 293
- Filament—310
- Files—199
- Filling stations—floodlighting—240
- Filtration plants—141
- Fire Department signal board—269
- Fitting rooms in stores—90, 92, 94
- Fixtures, artistic—118, 119, 285
- Flag lighting—308
- Floodlighting—233
  - applications of—232, 307, 308
  - athletic grounds—308
  - auto displays—253, 279
  - band stand—242
  - banks of projectors—234
  - buildings—232, 237, 307
  - calculations—307
  - churches—238
  - flags—308
  - lamps for—312
  - landmark—242
  - loading platform—308
  - monuments—238
  - office buildings—235, 307
  - public utilities buildings—235
  - projectors—306
  - projector No. 49 or "Sun"—306
  - projector No. 37 or "Moon"—306
  - projector No. 25 or "Star"—307
  - show window displays—301
  - signs—243
  - supports for projectors—234, 237, 307
  - towers—238
  - waterfalls—243
  - windmill—242
- Floor pedestal lighting—95, 98, 104, 166
- Fluoroscopic room—199
- Football practice and games—308
- Foot-candle—310
- Foot-candles recommended
  - commercial interiors—279
  - industrial interiors—280
  - outdoor lighting—308
- Footlights—128
- Forge room, foundry—280
- Foundries—208, 280
- Formula for computing lamp-size—281
- Foyer of theatre—121
- Furniture store windows—247, 254, 256

- Gallery in art museum—157, 160, 279
- Garage—279
- Gasoline filling stations—240, 308
- General illumination, direct lighting—291
- Glare—43, 46, 310
- Glass, absorption of—312
- Glo-Ray—196, 288
- Gothic fixture for churches—118
- Greek and Roman lamps—17
- Government buildings—137
- Gymnasium lighting—219, 279, 293
- Gymnasiums combined with assembly halls—147, 149

- Handball—224, 279, 293
- Hairdressing shop—97
- High bay lighting—206, 208, 291
- History of the lighting art—15
- Hockey—218, 231
- Home lighting—201
  - with indirect portable lamp—203, 286
- "Hood" reflector, No. 731—299
- "Hood, Junior" reflector, No. 11—305
- "Hoodette" reflector for display cases—305
- Hospital—193, 279, 287
  - children's room—194
  - fluoroscopic room—199
  - lobbies—192
  - nurseries—194
  - operating rooms—197, 288
  - private rooms—194
  - reception room—192
  - special laboratories—199
  - supply room—199
  - wards—193
- Hotel—175, 279
  - ballrooms—178
  - dining rooms—177
  - lobbies—174
  - roof gardens—178
- Hue—310
- Hygienic aspect of lighting—42

- Ice skating—218, 231, 308
- Illumination—277, 310
- Illumination in foot-candles
  - commercial—279
  - industrial—280
  - outdoor lighting—308
- Illumination computation formula—281
- Illumination terms—309
- Illuminometer—310
- Incandescent lamp—22, 312
- Indirect illumination—38, 284
- Indirect lighting—38, 277, 284, 310
  - almost equal to daylight—46
  - Bank-Ray—290
  - column clusters—102, 105
  - equipment for—284
  - fixtures, spacing and hanging—278, 284
  - for display rooms—91
  - from bank partitions—81, 289
  - from brackets—83, 289
  - from column caps—105
  - from coves and cornices—106, 112, 286
  - from floor pedestals—95, 99, 104
  - from wall boxes—102
  - in banks—78, 289
  - in church auditoriums—106, 112
  - in clubs—166, 170
  - in drafting rooms—214, 279
  - in hospital operating rooms—198, 288
  - in hotels—175, 279
  - in offices—69, 284
  - in schools—116, 143, 284
  - in show room from column clusters—102
  - intensities recommended—279
  - method of calculation—281, 284
  - planning—278, 281
  - portable lamp—201, 286
  - reflectors for—285
- Indoor sports—219
- Indoor Courts—219, 293
- Industrial lighting—207, 280, 291
- Industrial lighting reflectors—211, 292
- Industrial plants
  - factories—206
  - power houses—206, 213
  - laboratories—210
- Installing, direct lighting reflectors—292
  - floodlighting units—307
  - of "Hoodette"—305
  - of "Scoopette"—304
  - show window reflector—298, 300
- Intensity of illumination—310
  - recommended for direct lighting—280
  - recommended for indirect lighting—279
- Interior finish—281
- Island show window—250

- Jewelry store—262, 280

- Kerosene lamp—21
- Kichen—205

- Laboratories—210
- Ladies' furnishings shops—92
- Lambert—310
- Lamp data—312
- Lamps
  - "Betty"—19
  - Edison's lamp—22
  - floodlighting—312
  - Greek and Roman—17
  - incandescent—21, 312
  - Lucerna and Venetian—20
  - petroleum or kerosene—20
  - prehistoric—15
  - vegetable oil—19
- Lantern, direct lighting in church—111, 118, 277, 295
- Lantern fixtures—111
- Laws of inverse squares—310
- Laws of light reflection—38

Libraries—150
Library
  bookrack lighting—155
Light
  absorption—55
  control of—38
  distribution curves—309
  laws of reflection of—36
Lighting
  artistic aspect of—49
  data and tables—309
  decrease due to dirt accumulation—67
  direct—207, 277, 290
  engineered—35
  from other than ceiling outlets—112, 114, 286
  from skylights—112, 157, 176, 294
  hygienic aspect of—42
  indirect—38, 277, 284, 310
  industrial—207, 213, 280, 291
  laws, industrial—207, 280, 291
  methods—277
  modern practice—61
  of show windows—245, 296
  planning of—275, 277
  semi-indirect—37, 277
  types of luminaires—118, 277, 284
  ultilitarian aspect of—36
Lighting art, history of—15
Lighting data and tables—309 to 312
Lighting from partitions—81, 289
Lighting legislation—66
Living room—200, 202
Lobby
  hospital—192
  hotel—174
  public building—136
  public spaces—186
  theatre—121
Local illumination, direct lighting—289
Lodges—169
Lodge rooms—169, 170, 279
  altar lighting—170
  auditorium—168
  consistories—172
  lounge—170
  organ balcony—173
Loss of efficiency of eye—43, 46
Lounge of club—170, 279
Louver—310
  for show window—300
Lucerna lamp—18
Lumen—310
Lumen per watt—310
Lumen method
  for direct lighting—291
  for indirect lighting—280, 284
Lumens of lamps—312
Luminaires of special design—50, 285
Luminous bowl—40, 277
  fixtures, dust cover for—66, 75
  fixture for office lighting—277, 284
  fixtures for churches—118, 277, 285, 295
  principle—277
Lumitone—56
Lunch room—182

Maintenance—67
Manual training—145
Market, public—98, 279
Masonic lodges—169
Mean spherical candle-power—311
Memorial auditorium—134
Men's furnishings—94, 248
Midget reflector, No. 515—305
Miscellaneous lighting—116, 265
Miscellaneous stores—97
Modern art exhibits—160
Modern lighting practice—61
Moderne lighting interpretation—63
Monument, floodlighted—238
Motion picture theatre—120
"Moon" projector No. 37 or 307—306
Mounting height—278
Multi-unit equipment for indirect lighting —205, 285, 287
Municipal auditorium—131
Museum of art—157, 160, 279
Music hall—146

Natural history—162
Nave—110
Nursery—194

Office—69, 72, 284
  building—69, 279
  building, floodlighted—235, 307
  lighting calculation—284
  lighting with luminous bowl fixtures—74, 277, 284
Opaque—311
Operating rooms, hospital—197, 288
Optical store—98
Optiphosis—44, 311
Outdoor lighting—308
Outdoor opera—127
Outdoor sports—230
  golf—231
  ice skating rink—231
  swimming pool—230
Outlet spacing—278

Painting gallery, art museums—156, 279
Pedestals, lighting from floor—104, 166, 203
Photograph studios—267
Photometer—311
Photometric curve—311
Planning lighting systems—275
  direct lighting—277, 291
  floodlighting—307
  indirect lighting—277, 284
  show case lighting—304
  show window lighting—296
Pool table—223, 293
Portable lamp for indirect lighting—201, 203, 286
Portable footlights—301
Portable floodlights—301
Power plants—206, 213, 235
Prehistoric lamp—15
Pressroom, printing—280
Printing plant—280
Private offices—69, 279, 284
Private rooms—194
Projectors—311
  illumination data—307
  No. 25 or 205—307
  No. 37 or 307—306
  No. 49 or 409—306
Projectors for floodlighting—306
Public assembly rooms—131
Public library—150
Public market—98
Public space in bank—78. 83. 286, 289
Public spaces—187
  arcades—189
  auditoriums—132
  elevator lobbies—188
  lobbies—186
  railroad station—191
  reception rooms—190

Quality of light—45
Quantity of light—47
Racquet court—225, 279, 293
Railroad drafting rooms—216
Railway stations—191
Reading rooms—138, 153
Reception rooms—190
Reflecting power of painted surfaces—312
Reflecting power of metal surfaces—312
Reflection coefficient—309, 312
Reflector—311
  diffuser—278
  for Bank-Ray equipment—88, 290
  X-ray—31
Reflector catalog numbers
  No. 3 for direct lighting—292
  No. 7 for wall cases and small windows —305
  No. 11 for wall cases and small windows —305
  No. 33A, window floodlight—301
  E-40 for cove lighting—285
  No. 44 "Pup" window floodlight—301
  EC-45 for coves and wall urns—286
  EC-50 for cove lighting—285
  EC-52 for cove lighting—285
  No. 54 "Jumbo" for direct lighting—292
  EC-68 for coves and wall urns—286
  EC-74 for cove lighting—285
  EC-80 for direct lighting Bank-Ray—290
  EC-100 for cove lighting—285
  EC-105 for indirect lighting Bank-Ray—290
  EC-150 for cove lighting—285
  H-199 "Hoodette" for display cases—305
  S-200 "Scoopette" for display cases—304
  EC-200 for cove lighting—285
  No. 400 "Jack" for show windows—299
  No. 410 "Jill" for show windows—299
  No. 500 "King" for show windows—299
  No. 510 "Queen" for show windows—299
  No. 535 for direct lighting—292
  No. 570 for direct lighting—292
  No. 575 for direct lighting—292
  No. 580 for direct lighting—292
  No. 590 "Big Boy" for direct lighting—292
  No. 696 "Big Boy" for direct lighting—292
  No. 700 "Big Boy" for direct lighting—292
  No. 710 "Big Boy" for direct lighting—292
  No. 720 "Scoopette" for display cases—304
  No. 731 "Hood" for show windows—299
  No. 740 "Hoodette" for display cases—305
  No. 770 for No. 54 "Jumbo"—292
  No. 778 "Scoop" for show windows—299
  No. 804 reflector for No. 33-A—301
  No. 821 for No. 25 or 205 projector—307
  No. 823 for No. 25 or 205 projector—307
  No. 831 for No. 37 or 307 projector—306
  No. 833 for No. 37 or 307 projector—306
  No. 841 for No. 49 or 409 projector—306
  No. 842 for No. 88 window flood—301
  No. 844 for No. 44 window flood—301
  No. 900 "Giant" for show windows—299
  No. 910 Leviathan for show windows—299
Representative Hall—137
Residence—201
  bed room—205
  dining room—204
  kitchen—205
  living room—200
  study—203
  sun room—202
Restaurants—181
  cafes—185
  cafeteria—183
  dining rooms—180

  lunch room—182
  tea room—184
  Roof gardens—178
Room efficiency—281
Room index table direct lighting—283
  indirect lighting—282
Rooms, drafting—215

SALESROOM, auto—102, 253, 279
Sanctuary lighting—108
Schools—143
  drafting room—145, 217
  libraries—150, 152
  lobbies—188
"Scoop Junior" reflector No. 7—305
"Scoop" reflector No. 778—299
"Scoopette" reflector—304
  case lighting with—304
Selection of show window reflectors—296
Service department in store—101
Service station, auto—103, 240
Shoe stores—95
Shops—91
Show case lighting 304
Showroom—91
  auto—102, 253
  lighted from flood pedestal—104
Show window lighting—245, 296 to 301
  auxiliary equipment—301
  ceiling flanges—300
  color equipment—300
  control ring—301
  floodlights—301
  how to select reflectors—296
  louvers—300
  methods of installing—298, 300
  planning window lighting—298
  portable footlights—301
  portable floodlights—301
  proper lamps and holders—297
  recessing reflectors—296, 300
  reflector illustrations—299
  selection of equipment—296
  spacing of reflectors—296
  spotlights—301
  super-lighting—296
  types and sizes of reflectors—297, 299
  window calculations—298
Show window reflectors
  installed above ceiling—300
  installing of—298
  selection of—296
  spacing of—296
Show windows—245, 296
  automobile salesroom—253
  banks—257
  clothing stores—249
  department stores—250
  electrical shops—255
  flower shops—253
  foreign windows—252
  furniture stores—247, 254, 256
  public service companies—255
  shoe store—256
Signs, floodlighted—243
Skating rink—218, 231, 279, 308
Skylight lighting—112, 157, 176, 294
Spacing distances
  direct lighting fixtures—278
  indirect lighting fixtures—278
Spacing show window reflectors—296
Special laboratories—199
Special lighting methods—113
Spectrum—311
Specular reflection—311
Sports—219, 293
  athletic clubs—220
  indoor—219
  arena—229
  billiards—223, 293
  bowling—223, 293
  field houses—220, 293
  gymnasiums—220, 293
  handball courts—224, 293
  ice skating—218, 231
  racquet courts—224, 293
  swimming pools—222
  squash—224, 293
  tennis courts—226
  outdoor—230
Spires, floodlighted—238
Spotlight—301
Squash racquet court—224, 279, 293
Stage lighting—127
Stair hall—190
"Star" projector No. 25 or 205—307
Stations of the cross—117, 295
Station waiting room—191
Statuary halls—161
Stock exchanges—266
Stock quotation boards—266
Store, lighted by column clusters—102, 105
Stores—91
  auto accessories—103
  candy shop—98
  china—101
  department—100
  display room—91
  display booth—92
  fitting rooms—90
  furniture—100
  general—100
  hairdressing shop—97
  ladies' furnishings—92
  men's furnishings—94
  optical—98
  public market—98
  Public Service Company—104
  shoes—95
  tire shop—103
Story of Curtis Lighting—25
Studios—267
Study rooms—203
Sun room—202
Sunday school rooms—116
Suspension chart direct lighting fixtures —278
  indirect lighting fixtures—278
Swimming pool—222, 230

TABLES lighting data—309
Tea rooms—184
Telephone exchanges—268, 308
Teller's cage lighting with Brackette—89, 289
Tennis court—226, 279, 308
Tennis squash court—224, 293
Terms, definitions of—309
The luminous bowl—40, 277
Theatre—121
  auditoriums—122
  cove lighting—123, 286
  lobbies—121
  orchestra pits—126
  outdoor opera—127
  stage lighting—128
Tire shop—103
Transmission—311
Transmission of glass—312
Towers, floodlighted—238
Traffic lighting—269, 308
Trap shooting—308
Types of luminaires—277, 284

UTILIZATION efficiency—281
Utilitarian aspect of lighting—36

VALANCE for show windows—296
Vegetable lamps—19
Visual acuity—311
Voltage drop—280

WALL brackets—289
Wall display case lighting—305
Wall urns—286
War Memorial Auditorium—135
Wards, hospital—193, 287
Waterfalls, floodlighting—243
Wattage rating—311
Wire guards—292
Wire size—312
Windmill floodlighting—242
Wiring—278
Working plane—311

X-RAY Bank-Ray lighting—290
X-Ray direct lighting, applications of—291
  planning—291
  reflectors, uses for—292
X-Ray floodlighting—233, 306
X-Ray indirect lighting, applications of—112, 214
  general principles—277, 284, 310
  methods of calculation for—284
X-Ray luminous bowl—40, 277
X-Raylets—303
X-Ray projectors—306
X-Ray reflector—31
X-Ray show case lighting—304

THE LIGHTING BOOK, although prepared under one guiding hand, represents the peculiar talents of the personalities making up the organization of Curtis Lighting, Inc. Its executives, illuminating engineers, artists, sales people, artisans, and others form a successful and harmonious association in which the natural abilities find expression because the individual is unhampered in the exercise of his creative imagination.

Other hands and minds contributed also to the making of the book. Mr. Paul Ressinger cooperated in its design and production, the half-tones and other engravings came from the shop of the American Photo-Engraving Company, the printing on Old Ivory paper was done by the Huron Press, the printed sheets were bound into volumes by Brock and Rankin,—all these are craftsmen of Chicago, the Great City by the Lake.

PRINTED IN U. S. A.

Date

621.321 C97

a39001 007328910b

72-1